GOOD MORNING

Current Advancements in Fluorides

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Introduction

- Fluorine is the 17th most abundant element in the nature.
- It is most electronegative and reactive of all elements, it reacts with its surrounding and is rarely found free or in elemental state.
- Fluoride ion is present in all water sources, including the ocean.
- The word fluoride is derived from Russian word ‘FLOR’ which comes from FLORIS which means destruction in Greek and from Latin word ‘FLUOR’ which means ‘to flow’ since it was used as flux.

- History of fluoride in dentistry is more than hundred years old.
- It begins with the arrival of Dr. Fredrick MacKay in Colorado springs in U.S.A, where he discovered some permanent stains on teeth of his patients which were referred as Colorado stains.
- MC Kay termed it as mottled enamel, later Dr. Trendley H. Dean made a thorough documentation of the degree of mottled enamel.

- Afterwards, a chemist Churchill identified, the anonymous element responsible for mottling is, fluorine.

- The term mottled enamel gave way to more exact term ‘dental-fluorosis’.

- Whilst almost all foodstuffs contain at least traces of fluoride, water and non-dairy beverages are the main.
- Main sources of ingested fluoride are toothpaste in very young children (who tend to swallow most of their toothpaste) and tea in tea-drinking communities.
- Inhaled fluoride is another source in some communities in China and Africa where coal containing very high levels of fluoride is burned indoors and aluminium mining is done.

- There are two delivery systems of fluoride for prevention of dental caries:

1. Systemic - E.g. fluoride in water, milk, salt etc.
2. Topical - Topical fluoride can be delivered in two ways:

- Self applied topical fluoride (e.g., fluoride tooth paste, fluoride mouth rinse, etc)
- Professionally applied topical fluoride (e.g., sodium fluoride, acidulated phosphate fluoride)

Role of Fluoride in preventive dentistry

- Fluoride has both beneficial and detrimental effects on human health.
- Fluoride is considered the corner stone of the preventive dentistry.
- It continues to be regarded as the pivot of the preventive dentistry because of its cariostatic efficacy.

- In terms of dental health, the prevalence of dental caries is inversely related to the concentration of fluoride in drinking water, while there is a dose-response relationship between the concentration of fluoride in drinking water and the prevalence and severity of dental fluorosis.

Advancements

Stannous Fluoride Dentifrice with Sodium Hexametaphosphate –

- In 2005, a stannous fluoride sodium hexametaphosphate (SFSH) formula was introduced offering protection against a broad range of health and cosmetic conditions commonly experienced by patients.

- Stannous fluoride has been incorporated in dentifrices since the 1950s to provide protection against caries, pathogenic bacteria, gingivitis, hypersensitivity, and the development of plaque.

- Sodium hexametaphosphate was first introduced in a dentifrice in 2000.
- It is a chemical whitening agent which has long been used to inhibit calculus.
- The SFSH formula combines the therapeutic benefits of 0.454% stabilized stannous fluoride with the calculus and stain -control characteristics of sodium hexametaphosphate in a low -water formulation dentifrice.

0.454% Stabilized Stannous Fluoride

- Fights plaque and gingivitis
- Provides long-lasting antibacterial action
- Protects against sensitivity
- Fights cavities
- Helps prevent dental erosion

Sodium Hexametaphosphate

- Whitens by extrinsic stain removal
- Helps prevent stains
- Inhibits calculus

- This technology is commercially available as Crest® Dual Action Whitening and Crest® Vivid White dentifrices.

- Even more recently, Crest® Pro-Health toothpaste was developed, which combines stabilized stannous fluoride and silica abrasive with sodium hexametaphosphate.

- This new dentifrice brings together the established cosmetic benefits of the sodium hexametaphosphate technology with the therapeutic benefits of a stabilized stannous fluoride dentifrice.

Fluoride containing bleaching agents –

- With the increasing demand for treatments to enhance aesthetic appearance, tooth bleaching is becoming a more common procedure in dental clinics.

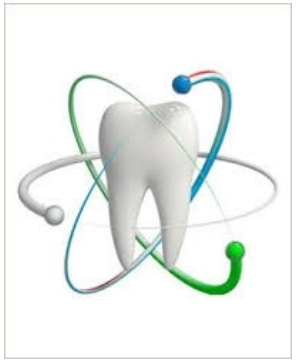
- However, some studies have reported altered surface morphology, increased tooth sensitivity, decreased microhardness and loss of dental hard tissue volume associated with bleaching treatments, although it can be reversed spontaneously following a remineralization period.

- Conventionally, topical fluoridation is used to increase the hardness and acid resistance of demineralized teeth.

- Recently developed bleaching agents containing additional ingredients such as fluoride, potassium nitrate and calcium phosphate have been introduced to prevent either hypersensitivity or demineralization after tooth-whitening therapy.

- Some studies show that the fluoridated bleaching agents produce less demineralization of surface morphology and microhardness and the addition of fluoride does not impede the whitening effect.

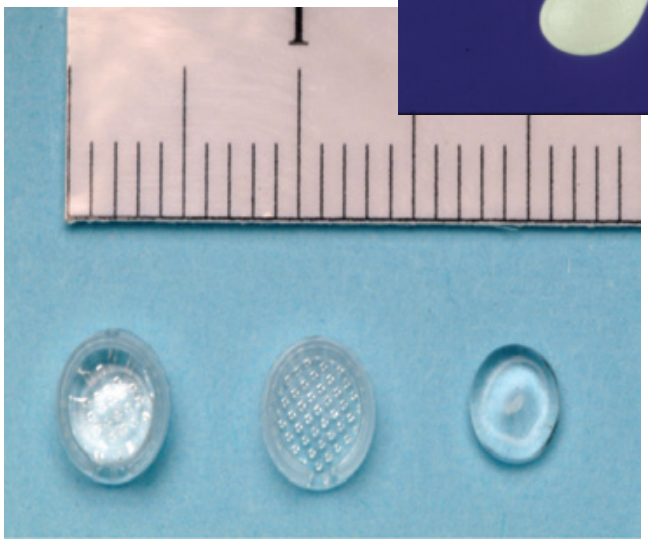
  Ex - 10% CP containing 0.11% Fluoride, experimental bleaching agent consisting of 10% CP and 0.37% Fluoride, additional sodium fluoride in hydrogen peroxide bleaching agent.



Slow-release fluoride devices –

- Fluoride has been used to combat dental caries using a number of different clinical approaches.
- An exciting relatively new development is fluoride slow-releasing devices that consistently elevate intra-oral fluoride levels of plaque and saliva for prolonged periods of up to two years.
- The intra-oral devices currently in development and use are of two types:

1. Copolymer membrane devices which was developed in USA
2. Glass devices that were developed in UK



- Three glass devices with different concentration have been tested in a pilot study by Curzon and Toumba [2004] to evaluate their fluoride release.

- It was shown that devices containing a fluoride concentration of 13.3% released more F than those that contained 18.3% and 21.9%.

- A slow-release fluoride device was under research at the Leeds Dental Institute in England.

- The Leeds model is a non-silica glass bead, 4mm in diameter, and is attached to the buccal surface of the maxillary first permanent molars.

- A two-year study, using fluoride slow-release devices in eight-year old children living in an inner city area of Leeds was undertaken (Toumba and Curzon, 2005).

- A dramatic 76% reduction in the development of new carious surfaces was noted compared to children who did not have such devices.

Hydroxyapatite-Eudragit RS100 diffusion controlled F system –

- This is the newest type of slow-release F device, which consists of a mixture of hydroxyapatite, NaF and Eudragit RS100.
- It contains 18 mg of NaF and is intended to release 0.15 mg F/day.
- It was demonstrated that the use of this device is able to significantly increase salivary and urinary F concentrations for at least 1 month.

- A novel delivery system by which fluoride incorporated into elastomeric rings, will be released in a controlled and constant manner was tried and tested.

- Polyethylene co-vinyl acetate (PEVA) was used as the model elastomer. Samples were prepared by incorporating 0.02 to 0.4 g of sodium fluoride (NaF) into previously prepared PEVA solution.

- Only coated samples with the highest fluoride content (0.4 g of NaF) were able to release fluoride at therapeutic levels.

AAP Recommendation for Fluoride use

- Dental caries – or tooth decay -- is the most common chronic disease in children in the U.S., a silent disease that disproportionally affects poor, young, and minority populations.
- In a new clinical report by the American Academy of Pediatrics (AAP) "Fluoride Use in Caries Prevention in the Primary Care Setting," published online Aug 25 in the September 2014 Pediatrics, the AAP states that fluoride is effective for cavity prevention in children.
- The AAP is issuing the following new recommendations:

- Fluoridated toothpaste is recommended for all children starting at tooth eruption, regardless of caries risk.

- A smear (the size of a grain of rice) of toothpaste should be used up to age 3. After age 3, a pea-sized amount may be used. Parents should dispense toothpaste for young children and supervise and assist with brushing.
- Fluoride varnish is recommended in the primary care setting every 3–6 months starting at tooth emergence.
- Over-the counter fluoride rinse is not recommended for children younger than 6 years due to risk of swallowing higher-than-recommended levels of fluoride.

(http://www.aap.org/en-us/about-the-aap/aap-press-room/Pages/AAP-Recommends-Fluoride-to-Prevent-Dental-Caries.aspx)

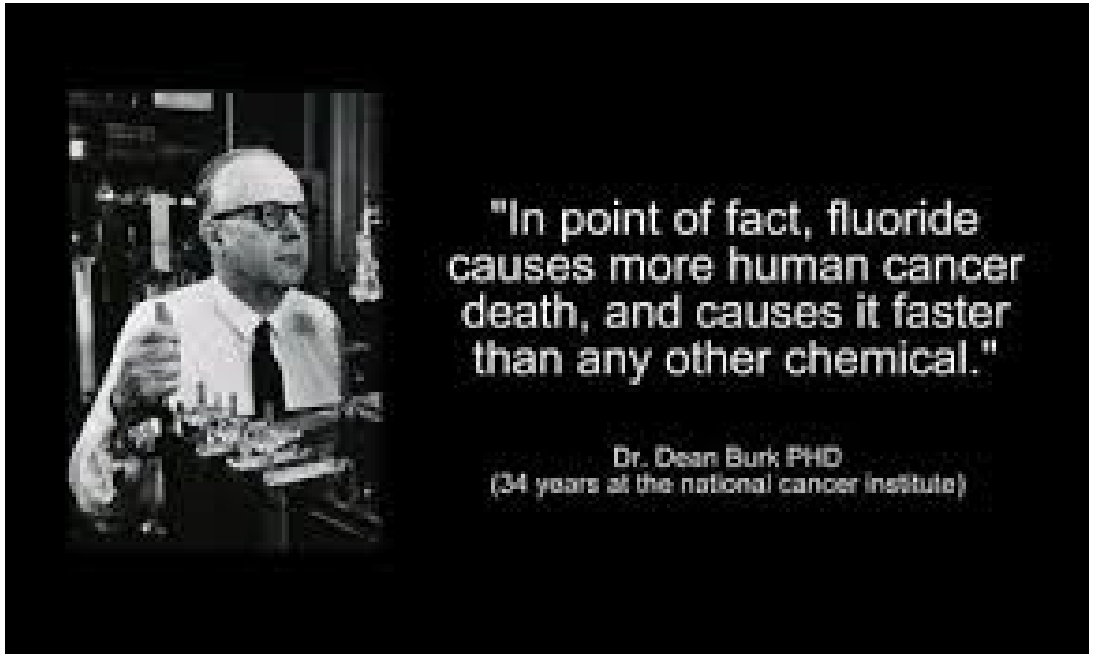
Fluoride --- The flip side

- Despite the presence of enormous data on the beneficial effects of fluorides in prevention of dental caries, the fact that fluoride has serious adverse effects can not be ignored.
- The most common side effect noticed is dental flurosis which occurs as a result of fluoride overdose and results in tooth discoloration, a condition called “mottled enamel”.
- In artificially fluoridated regions, dental flurosis is now much more prevalent and severe than the initial proponents of fluoridation predicted.

- The University of York's Fluoridation Review estimates that up to 48% of children in fluoridated areas have some form of dental fluorosis.
- In addition to dental fluorosis there is also a large and growing body of research on a fluoride-induced bone disease called skeletal fluorosis.
- International Programme on Chemical Safety (IPCS), have carried out a detailed review of fluoride and the potential for impacts on health.

- Most people assume that these severe manifestations of skeletal fluorosis occur at much higher fluoride levels than the 1 ppm.
- To the contrary, few cases are even reported in India, China and Africa where even at fluoride concentrations slightly or far below 1 ppm.
- In India and China naturally occurring fluoride is regarded as a chronic poison and the main issue is how to remove it from drinking water as effectively and cheaply as possible.

- A wide range of adverse effects has been reported.
- These include not only dental and skeletal fluorosis but also increased risk of bone fractures, decreased thyroid function, lowered IQ, arthritic-like condition, and possibly, cancers like osteosarcoma.



- Fluoride increases the uptake of aluminium into the brain at 1 ppm in the drinking water.
- It has been suggested that aluminium fluoride (AlF_3) complexes might induce alterations in homeostasis, metabolism, growth and differentiation in living organisms.

- Malfunctioning of G-proteins could be a causal factor in many human diseases, including Alzheimer's disease, asthma, memory disturbance, migraine and mental disorders.

- Dr. NJ Chinoy from Gujarat University, India, has found that higher doses of fluoride cause reproductive problems. It can cause accelerated sexual maturation or earlier onset of puberty.

Benefits of Fluoridation - a fallacy

- A major cross sectional survey of eighty four cities in the USA by JA Brunelle and JP Carlos (1990) at the National Institute of Dental Research found that children aged 5-17 years, who had lived their whole lives in fluoridated cities, had on average only 0.6 fewer decayed, missing and filled tooth surfaces (DMFS) per child than those in non fluoridated cities.

- In Australia a survey by Professor John Spencer from University of Adelaide (1996) found an average reduction of only 0.12 to 0.3 DMFS per child.

- Today, according to data from the World Health Organization, there is no discernible difference in tooth decay between the minority of developed countries that fluoridate water, and the majority that do not.

- Fluoride is also not approved by the U.S. Food and Drug Administration (FDA) to be given as a supplement.

(www.fluoridealert.org/researchers/fda/not-approved/)

- California is 28% fluoridated and Hawaii is just 9% fluoridated.
- These states are tied for the lowest rate of tooth loss in the USA.
- On the other hand, Kentucky is 100% fluoridated and has the highest toothless population of older adults.

(Poonam Mahajan, K. L. Veersha, Ajay Mahajan. Is fluoride still a pivot of preventive dentistry? European Journal of General Dentistry January-April 2013; Vol 2, Issue 1: 20-24.)

- In (fluoridated) Detroit, 91% of 5-year-old black children have tooth decay, with 42% suffering from “severe” decay.

(Ismail AI, et al. (2006). Severity of dental caries among African American children in Detroit. http://iadr.confex.com/iadr/2006Orld/techprogram/abstract_73168.htm)

- In (fluoridated) New York City, 34% of pre-school black children from low-income families have rampant tooth decay, with a staggering 6.4 cavities per affected child.

(Albert DA, et al. Dental caries among disadvantaged 3- to 4-year-old children in northern Manhattan. Pediatric Dentistry 2002; 24: 229-33.)

- In (fluoridated) Chicago, 64% of third graders have tooth decay.

(Bridge to Healthy Smiles. Cook County Oral Health Crisis. http://www.bridgetohealthysmiles.com/ISDSBrochure.pdf)

- In San Antonio, annual head start surveys show that fluoridation failed to reduce the high rate of tooth decay among the city's head start children. After eight years of fluoridation, the tooth decay rate did not decrease, rather, it increased.

(Bexar County Head Start Dental Screenings Program. www.fluoridealert.org/uploads/san_antonio_caries.pdf)

- A national survey by the CDC found that the most fluoridated state in the U.S. (Kentucky) suffers the highest rate of tooth loss (44%) while the least fluoridated state (Hawaii) suffers the lowest rate of tooth loss (16%).

  (Centers for Disease Control. (1999). Behavioral Risk factor Surveillance System. http://drc.hhs.gov/report/4_3.htm)

- Untreated tooth decay in fluoridated urban areas has led to several deaths, including a 12-year-old child in Prince Georges Maryland, 12-year-old Deamonte Driver and a 24-year-old father in Cincinnati.

  (Carrie Gann, Man Dies from Toothache, Couldn't Afford Meds, ABC News, Sept. 11, 2011, and Laura Owings, Toothache Leads to Boy's Death, ABC News, March 5, 2007. http://abcnews.go.com/Health/insurance-24-year-dies-toothache/story?id=14438171)

- The early studies conducted in 1945-1955 in the US, which helped to launch fluoridation, have been heavily criticized for their poor methodology and poor choice of control communities.

- According to Dr. Hubert Arnold, a statistician from the University of California at Davis, the early fluoridation trials “are especially rich in fallacies, improper design, invalid use of statistical methods, omissions of contrary data, and just plain muddleheadedness and hebetude.”

- In 2000, the British Govertment’s “York Review” could give no fluoridation trial a grade A classification – despite 50 years of research.

(Dr. Paul Connett. 50 reasons to oppose fluoridation.)

- The US Public Health Service first endorsed fluoridation in 1950, before one single trial had been completed.

- Despite the fact that we are exposed to far more fluoride today than we were in 1945 (when fluoridation began), the “optimal” fluoridation level is still 1 part per million, the same level deemed optimal in 1945.

(Dr. Paul Connett. 50 reasons to oppose fluoridation.)

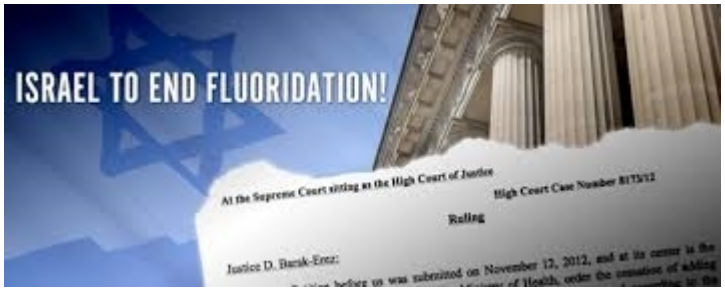
- A systematic review of water fluoridation done by Marian S McDonagh et al (2000) reveals that the quality of the evidence is low (lack of appropriate design, analysis and measure of variance; no attempt to control for potentially confounding factors and observer bias) and overall, reductions in the incidence of caries were found, but they were smaller than previously reported.

(Marian S McDonagh. Systematic review of water fluoridation. BMJ 2000;321:855–9.)

- On 9 August 2007, the Fluoride Action Network (FAN) statement signed by over 600 professionals, stated that it is time for advanced nations and fluoridating countries to recognize that fluoridation is outdated and has serious risks that far outweigh any minor benefits, violates sound medical ethics and denies freedom of choice.

- As of November 2013, a group of over 4549 professionals including 361 dentists and 562 medical doctors have added their names to a petition aimed at ending fluoridation started by the Fluoride Action Network.

- Communities have discontinued water fluoridation in some countries, including Finland, Germany, Japan, the Netherlands, Sweden, and Switzerland. On August 26, 2014, Israel officially stopped adding fluoride to its water supplies.



Defluoridation

- Fluoride is often described as a ‘double-edged sword’ as inadequate ingestion is associated with dental caries, whereas excessive intake leads to dental, skeletal and soft tissue fluorosis, which has no cure.

- Considering the fact that fluorosis is an irreversible condition and has no cure, prevention is the only solution for this menace.

- Providing water, with optimal fluoride concentration is the only way by which the generation yet to be born can be totally protected against the disease.

- Defluoridation was the conventional and widely tested method for supplying safe water to the fluorosis affected communities.

- Various techniques and materials were tried throughout the world for defluoridation of water.

- Defluoridation techniques can be broadly classified in to four categories - Adsorption technique, Ion-exchange technique, Precipitation technique, and Other techniques, which include electro chemical defluoridation and Reverse Osmosis.

Advancements in Defluoridation techniques

1. A study found that aluminum oxalate can be used as defluoridating agent in soil pots without effecting the environment as a Green Chemical Approach.

2. A study concluded that calcium carbonate pretreatment followed by reverse osmosis membrane was essential for effective fluoride removal and is an economical procedure wherein no secondary waste is generated.

3. Activated alumina after pretreatment with aluminium sulphate has given promising results for removal of fluoride from drinking water. Results even revealed excellent performance of regenerated activated alumina for removal of fluoride in drinking water. This innovation of regeneration makes the system economical on one hand and also avoids the logistic requirement of changing the adsorbent after every cycle of saturation on the other hand.

4. A study showed that Vetiveria zizanioides, a herbal plant of Kerala - commonly known as Vetiver is an effective adsorbent for the removal of fluoride from aqueous solution. Phosphoric acid activated Vetiver root showed good adsorption capacity of fluoride ions than the fresh powdered Vetiver root.

5. The results of a study showed that by doubling the concentrations of alum and lime, water fluoride levels fell significantly ($p<0.001$) in tap water and drinking water while pH levels and other inorganic factors remained unaffected when compared to the existing Nalgonda technique.

6. The metal embedded biocarbon sorption method is promising in defluoridation of drinking water. The results of the study highlight the use of indigenous medicinal plants for the removal of fluoride in ground water. It is economically feasible option because of its bioavailability and its efficiency.

7. Modified immobilized activated alumina (MIAA) has efficiently been utilized for the removal of fluoride from drinking water with the removal efficiency upto 95%. MIAA can both be regenerated thermally and chemically.

8. Tamarind seed, a household waste from the kitchen is used for the sorptive removal of fluoride from synthetic aqueous solution as well as from field water samples.

9. The activated tea ash is promising material for fluoride removal from aqueous solution as well as contaminated groundwater.

Fluoride alternatives

- A lot of research is going on towards efforts to develop new methods to prevent caries for e.g., caries vaccine, laser, probiotics, benign microorganism replacement therapy, Self assembling polypeptides (SAP), caries preventive chewing gums, microdentistry, teledentistry etc.

- Genetic engineering is also providing better alternatives by mutating a gene which controls the acid production in S. Mutans.

Public Health Significance

- Despite great improvements in the oral health of populations across the world, problems still persist particularly among poor and disadvantaged groups in both developed and developing countries.

- According to the World Oral Health Report 2003, dental caries remains a major public health problem in most industrialized countries, affecting 60–90% of schoolchildren and the vast majority of adults.

- Research on the oral health effects of fluoride started around 100 years ago; the focus has been on the link between water and fluorides and dental caries and fluorosis, topical fluoride applications, fluoride toothpastes, and salt and milk fluoridation.

- As fluorides are considered very effective for dental caries reduction, the advancements taking place in this field need to be considered for improvement of oral health status of public at large.

Conclusion

- Fluoride because of its anti-caries action was considered pivot of preventive dentistry.
- It was considered as double edge sword as the excess amount was responsible for dental as well as skeletal fluorosis, which is incurable.
- But its benefits as anti-caries element were so much endorsed that it over shadowed its serious side effects.
- But with changing scenario, attention is now being drawn on potentially permanent damaging effect of fluoride.

- A review of literature on fluoride research reveals a situation where people in fluoridated communities are required to ingest a harmful and ineffective medication with uncontrolled dose.

- The medication actually doesn’t need to be swallowed, since it acts directly on tooth surfaces.

- The benefit of fluoridation is at best a reduction in tooth decay in only a fraction of one tooth surface per child.

- It is time for advanced nations and fluoridating countries to recognize that fluoridation is outdated and has serious risks that far outweigh any minor benefits, violates sound medical ethics and denies freedom of choice.

- With the advancement of recent methods for caries prevention, role of fluoride in preventive dentistry needs to be readdressed.

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THANK YOU


Did you know?
When you boil a pot of water,
the fluoride concentration in the pot of water
INCREASES!