
HAVE A SWEET DAY
GOOD MORNING!
SantaBanta.com

D Y PATIL DENTAL SCHOOL

DEPARTMENT OF
PUBLIC HEALTH DENTISTRY

TOPICAL FLUORIDE

CONTENTS

Introduction

- The word fluorine is derived from Russian word ‘FLOR’ which comes from Greek word FLORIS which means destruction and from Latin word ‘FLUOR’ which means ‘to flow’ since it was used as flux
- Discovered by Karl Scheele in 1771
- First isolated by Moissan in 1886 (Nobel Prize for Chemistry in 1906)

Introduction

- Fluorine: an essential nutrient (Federal Register of US FDA)
- Included in the list of 14 elements recognized to be physiologically essential for the normal development and growth of human beings (WHO Expert Committee on Trace Elements)
- 17th most abundant element in the earth's crust : Constitutes about 0.06-0.09% by weight of the crust
- Usually classed with trace elements
- Apparently ubiquitous

Chemistry

- Element #9 in the Periodic Table with Atomic weight 19
- First member of Halogen Family
- Pale yellow, corrosive Gas
- Most electronegative and reactive of all elements
- Attacks all elements except Oxygen & Nitrogen
- Exclusively monovalent

History of Fluorides

1822	Berzelius	Suspected that Fluoride was present in water
1846	Wilson	First reference to the presence of fluoride in water in Britain
1874	Erhadt	First reference to the prophylactic role of fluoride
1888	Kuhns	First reported observations of mottled enamel
1893	Hillebrand	First report of fluoride concentration in drinking water quoted in ppm
1901	McKay	First noticed hitherto unknown condition in Colorado, known as “Colorado Stains” & named it as “Mottled Enamel”
1902	Colorado Springs Dental Society	First systematic endeavour to investigate the lesion

History of Fluorides

1905	McKay	Moved to St Louis to practise orthodontics – Stayed for 3 years
1908	McKay	Returned to Colorado
May, 1908	McKay	Revived the question at the El paso Country Odontological Society
June, 1908	McKay	Sent to Boulder along with a "Mottled enamel" patient for presentation at the annual gathering of the State Dental Association
		McKay approached Dr Greene Verdiman Black → he agreed to attend the Colorado State Dental Association meeting in July 1909 & promised to spend some weeks in Colorado Springs before the annual meeting
	McKay & Dr Isaac Binton	Examined 2945 children in the public schools of Colorado Springs & discovered that 87.5% of the children native to Colorado Springs had mottled enamel

History of Fluorides

June 1909	G V Black	Arrived in Denver, checked the report submitted by McKay & addressed the State Dental Association, his histological findings of mottled enamel
1912		McKay received reports from various parts acknowledging the same condition present in those areas (Smavillo, Texas; Tacoma, Washington, Rapid City, south Dakota, Mojave City, Arizona)
Oct 1916		McKay visited Britton, South Dakota after learning about presence of similar condition there from Dr O E Martin→ Discovered that in 1898, Britton had changed its water supply from individual shallow wells to a deep drilled artesian well
1 July, 1925		New pipeline to bring water supply was constructed from Carpenter Spring near Oakley to Oakley, Idaho which earlier received water supply from a warm spring 5 miles out of town

History of Fluorides

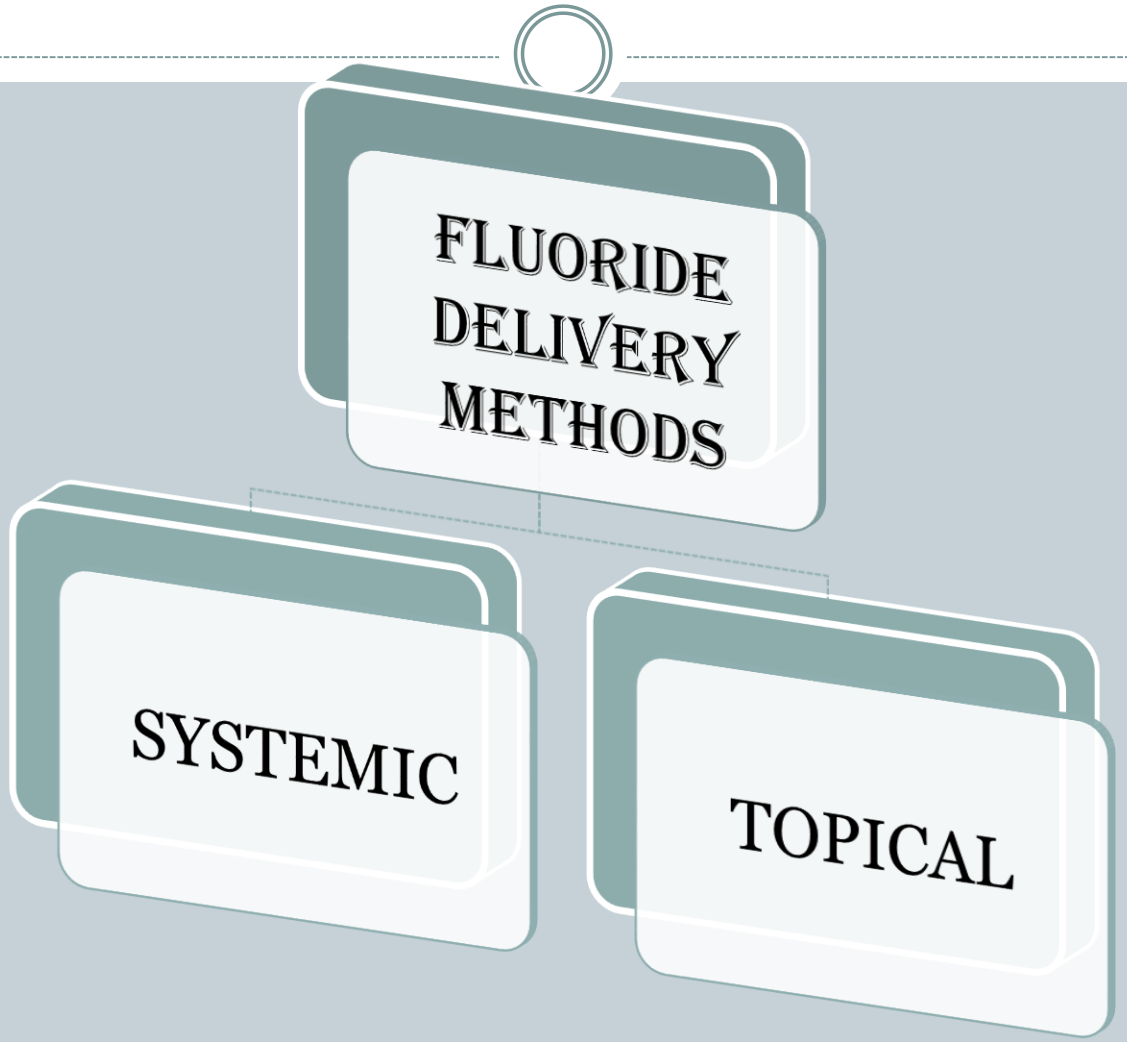
1928		US Public Health Service asked Dr McKay to accompany Dr Gromer Kempf to conduct the examinations for mottled enamel → Found that no mottling occurred in people who grew up on Bauxite water prior to 1909 but all native Bauxite children who used deep well water after that date had mottled enamel.
17 April 1928	McKay	Chicago Society presentation: Caries experience was reduced by the same water that produced mottled enamel
1931	H V Churchill	He received a sample of water from Bauxite (from where ALCOA mined most of its Al supply) and asked Mr A W Petrey, Head of the testing division of the ALCOA Lab, to look for traces of rare elements using the newly discovered spectrographic analysis & reported that it contained F at the level of 13.7 ppm

History of Fluorides

1931	Churchill	Asked McKay to send samples of water from other endemic areas
	Deep well, Bauxite	13.7 ppm F
	Colorado Springs	2 ppm F
	Well near Kidder, S Dakota	12 ppm F
	Well near Lidgerwood, N Dakota	11 ppm F
	Oakley, Idaho	6 ppm F
1931	Dr Margaret Smith & Howard Smith	Produced mottled enamel experimentally in rats
1931	Dean	Shoe Leather Survey
1934	Dean	Fluorosis Index

History of Fluorides

1942	Bibby	Repeated application of NaF or KF to teeth of children significantly reduced caries prevalence which was basis for various topical agents.


FLUORIDE DELIVERY METHODS
SYSTEMIC
TOPICAL

TOPICAL FLUORIDES

Definition: The term “topically applied fluorides” is used to describe those delivery systems which provide fluoride for a local chemical reaction to exposed surfaces of the erupted dentition.

The delivery systems include measures designed for professional application in the dental office, such as fluoride –containing prophylactic pastes, solutions, gels and varnishes, as well as systems designed for unsupervised home use, such as fluoride dentifrices and rinses.

TOPICAL FLUORIDES

- They strengthen teeth already present in the mouth, making them more decay-resistant. Topical fluorides include toothpastes, mouth rinses & professionally applied fluoride therapies.
- Topical fluorides are of 2 types :

- Self-Applied
- Professionally-Applied

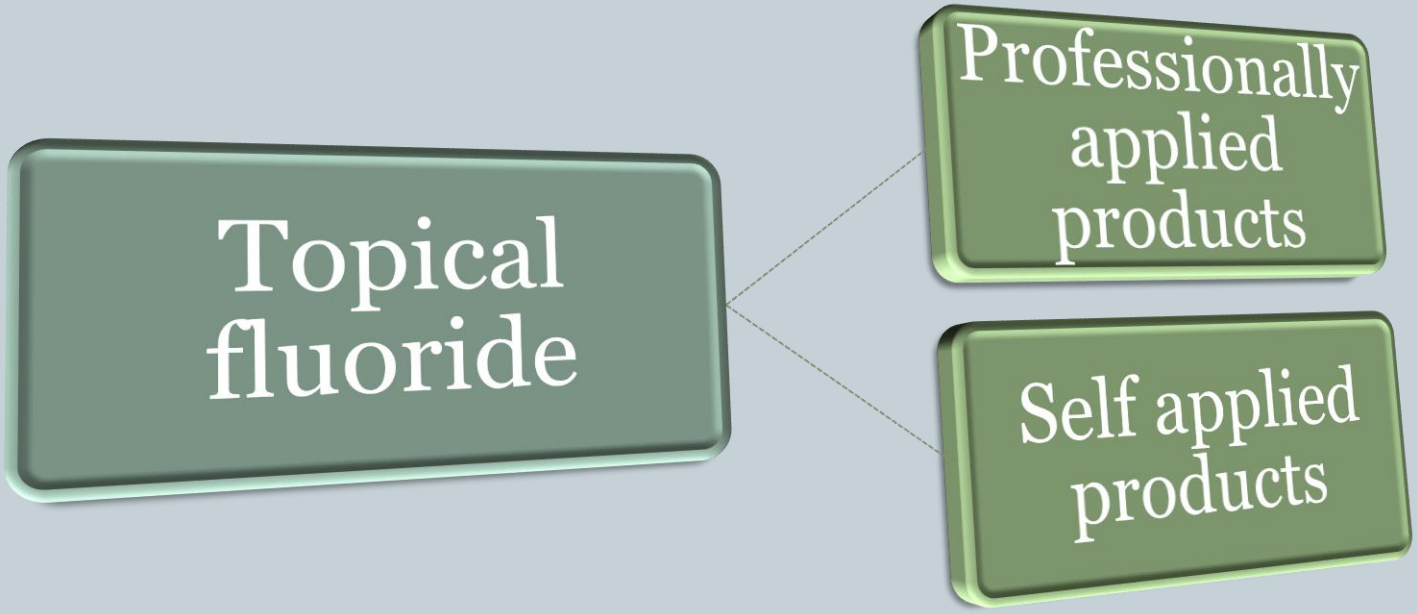
RATIONALE

Topical fluorides enhance natural process of fluoride acquisition

Speed rate and increase concentration of F acquisition

Porous , immature enamel

Initial carious lesion, white spot is porous


Topical fluoride
Professionally applied products
Self applied products

Caries reduction by fluorides

Method	Average %tage reduction of dental caries
Community Water fluoridation	50-65%
School water fluoridation	40%
Dietary fluoride supplements	50-65%
Professionally applied topical fluoride	30-40%
Self applied topical fluoride	20-50%

SELF APPLIED

- One method of self-applied topical fluoride that is responsible for a significant drop in the level of cavities since 1960 is use of a fluoride-containing toothpaste.
- Other sources of self-applied fluoride are mouth rinses designed to be rinsed & spit out.
- For patients who have unusual susceptibility to dental caries (due to dry mouth, medical conditions, or other factors) dentists may recommend a prescription fluoride gel or paste to be used in addition to regular toothpaste.

PROFESSIONALLY APPLIED

- In the form of a gel or foam, applied by a dentist or dental hygienist.
- More concentrated
- Due to which not needed frequently

Typically dispensed by dental professional in the dental office setting

High F conc products – 5000 to 19000 ppm(5- 19mgF/ml)

Bought & dispensed by individual patient at dental professional recommendation

Low Fluoride products(dentifrices, mouthrinses, gels)

200 – 1000 ppm (0.2to 1mgF/ml)

INDICATIONS OF TOPICAL FLUORIDE

- Caries active individuals
- Shortly after tooth eruption esp. those with caries
- Medications or radiations causing xerostomia
- After periodontal surgery when roots have been exposed
- Fixed and removable prosthesis
- Placement and replacement of restorations
- Eating disorder, change in lifestyle
- Specially disabled children

Mechanism of Action

Mechanisms of Action

- Topical
- Systemic
- Antibacterial

Mechanisms of Action

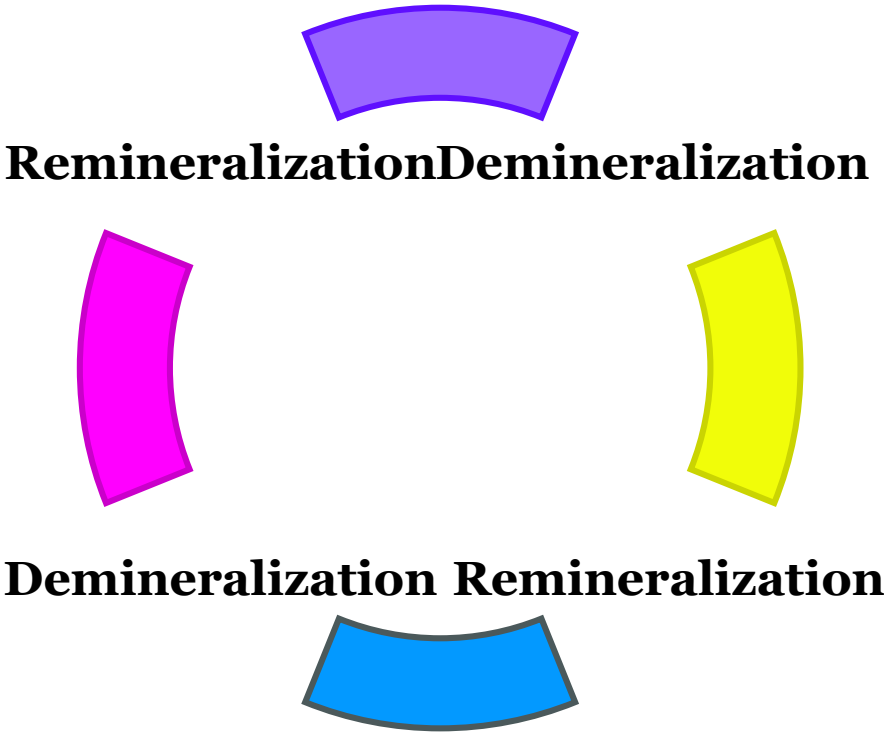
- *Topical*
  - inhibits demineralization
  - promotes remineralization

Mechanisms of Action

- Fluoride's role in remineralization
  - When bacteria metabolize carbohydrate and produce acid, fluoride is released from dental plaque in response to lower pH levels at the tooth interface (Tatevossian, 1990).
  - To be more acid resistant and contain more fluoride and less carbonate, the demineralized enamel crystal structure takes up released plaque fluoride and salivary fluoride along with calcium phosphate.

Mechanisms of Action

- The pH in the oral cavity falls within seconds of ingestion of dietary sugars.
- The pH can stay low for up to two hours.
- Low pH leads to demineralization of the tooth structure.
- When pH returns to normal/neutral, remineralization can occur.
- The original mineral apatite structure of teeth is rich in carbonate, has relatively little fluoride and is relatively soluble.
- Cycles of partial demineralization and remineralization in a fluoride-rich environment can create fluoride-rich, low-carbonate apatite, which is up to 10X less soluble than the original apatite structure.



Mechanisms of Action

- *Systemic*
  - improves enamel crystallinity
  - reduces acid solubility
  - improves tooth morphology (controversial)

Mechanisms of Action

- Several studies have reported that teeth formed in fluoridated communities or exposed to fluoride supplements pre-eruptively tend to be smaller and have shallower pits and fissures than teeth formed in non-fluoridated communities or not exposed to pre-eruptive fluoride supplements (Lovius et al, 1969; Simpson, et al, 1969; Aasenden, et al, 1974).
- These researchers believe that even if the differences are small and do not entirely explain lower caries prevalence, the very fact that measurable alterations in tooth morphology occur when there is pre-eruptive exposure to fluoride indicates that there must be some effect from exposure to fluoride during tooth development.

Mechanisms of Action

- *Antibacterial*
  - concentrates in plaque
  - disrupts enzyme systems
    - Fluoride inhibits bacterial metabolization of carbohydrates to produce acid and affects the bacterial production of adhesive polysaccharides (Hamilton, 1990).
    - When fluoride is constantly present, mutans Streptococci produce less acid (Bowden, 1990).

Pre-eruptive vs. Post-eruptive Fluoride

- Pre-eruptive fluoride exposure = systemic fluoride exposure
- Post-eruptive fluoride exposure = topical fluoride exposure

According to the CDC 2001 Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States (at the website), ". . .laboratory and epidemiologic research. . .indicates that fluoride's predominant effect is post-eruptive and topical."

HOWEVER. . .

- Clinical epidemiologic data demonstrate both pre- and post-eruptive caries-preventive benefits to teeth from fluoride.

A recent report showed that pre-eruptive exposure to fluoride in Australian children 6 to 15 years old was required for a caries-prevention effect in first permanent molars and that exposure to fluoride after eruption alone did not alter caries level significantly (Singh, et al, 2003).

Maximal caries-preventive effects of fluoridated water were achieved by high pre- and post-eruption exposure.

Whole intention

- Hydroxyapatite → Fluoroapatite
- Formation of insoluble coating on enamel surface esp.

  heavy metal cations such as Tin, Zirconium and Titanium

Summary of Anti-Caries Activity of Fluoride

1. Fluoride prevents demineralization.
2. Fluoride enhances remineralization.
3. Fluoride alters the action of plaque bacteria.
4. Fluoride aids in posteruptive maturation of enamel.
5. Fluoride reduces enamel solubility.

FACTORS AFFECTING TOPICAL FLUORIDE DEPOSITION IN TEETH

- Tooth condition

Tooth age
Natural fluoride concentration
Enamel defects
Dentine/ cementum

- Treatment formulation

Fluoride agent
pH
Fluoride concentration
Formulation components
abrasives

Factors affecting topical fluoride deposition in teeth

- Application procedure

Prophylaxis

Effect of time

Temperature

Number of application

Sequential APF- SnF2 applications

Enamel pretreatment

Barrier coating

Case History
Satisfactory knowledge, attitude and behavior relating to diet, eating habits, oral hygiene, and the use of fluorides.

Information – need for and planning of, an appropriate caries preventive regimen
Consideration – patient compliance with planned preventive measures
Economic, social, psychological factors

Potential fluoride compound with caries preventive topical agent

PbF

KF

Ammonium fluoride

Zirconium fluoride

Titanium tetra fluoride

Potassium fluorostannate

Sodium hexa fluorostannate

None proved superior in inhibiting dental caries

Currently in use

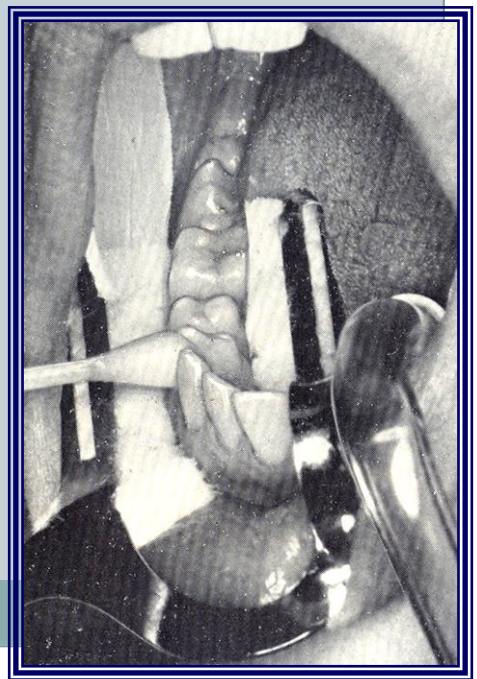
- **Neutral sodium fluoride**
- **Acidulated phosphate fluoride**
- **Stannous fluoride**

SODIUM FLUORIDE

- Studies were independently initiated by Bibby in 1940s & by Knutson of US Public Health Service

- Method of Preparation :
  - To prepare 2% NaF –20 gms of NaF is dissolved in 1 liter distilled water in a plastic container
- Technique of application :

  (Knutson & Feldman tech 1948)
  - Prophylaxis
  - Isolation
  - 2% NaF applied
  - Allowed to dry 3 – 4 min



- NaF is applied once because once a layer of CaF_2 is formed it interferes with further diffusion of F^- to react with hydroxyapatite. This is called as choking off phenomenon
- Repeated on other quadrants
- Instructed not to eat, drink or rinse for 30 min

- No. of application :
- 2^{nd}, 3^{rd}, 4^{th} applications are done at weekly interval.
- Application is recommended at 3, 7, 11 & 13 years.

Mechanism of action :

$Ca_{10}(PO_4)_6(OH)_2 + 20F^{--} \leftrightarrow 10CaF_2 + 6PO_4^{--} + 2OH^-$

[hydroxyapatite]

$CaF_2 + 2Ca_5(PO_4)_3OH \leftrightarrow 2Ca_5(PO_4)_3F + Ca(OH)_2$

[fluorapatite]

Fluorapatite

-- makes tooth structure more stable

-- less susceptible to acid dissolution

-- interferes with plaque metabolism through antienzymatic action

-- helps in remineralization of initial decalcified areas

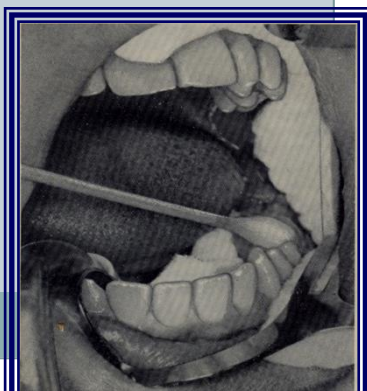
- Advantages :
  - Chemically stable
  - Acceptable taste
  - Non-irritant to gingiva
  - Does not discolor teeth
  - Inexpensive

- Disadvantages :
  - 4 visits within a short time

29 to 30% Caries reduction

STANNOUS FLUORIDE

- 2nd to gain wide acceptance → Efforts of Muhler & associates at Indiana University
- Method of Preparation :
- To prepare 8% SnF2 – 0.8 gms is dissolved in 10 ml of distilled water in a plastic container and shaken.
- To prepare 10% SnF2 -1gm is dissolved in 10 ml of distilled water
- Technique of application :(Muhler Tech)
- Prophylaxis & Unwaxed floss passed interproximally
- Teeth are isolated with cotton rolls
- SnF2 is applied with cotton applicators



- Solution is applied continuously keeping the teeth moist for 4 min
- Instructed not to eat, drink or rinse for 30 min
- No. of applications: Annual or biannual
- **Disadvantages** :
- Unstable – Becomes cloudy soon after mixing due to formation of tin hydroxide
- Metallic, Astringent taste due to tin hydroxyphosphate
- May cause gingival irritation
- Causes brown pigmentation of teeth particularly in hypocalcified areas
- Causes staining on margins of restorations → Due to deposition of tin phosphates which with time transform into coloured tin sulfides
- Average 32% caries reduction

- Mechanism of action :

Sn & F ions of SnF_2 react with HA to form 4 compounds:

- Stannous trifluorophosphate (More resistant to decay than enamel)
- Tin hydroxyphosphate $Sn_2(OH)PO_4$: Metallic taste
- Tin trifluorophosphate $Sn_3F_3PO_4$
- Calcium trifluorostannate $Ca(SnF_3)_2$ (Formed when F is in high concentration)

MOA of Stannous Fluoride

SnF2 is naturally acidic 8% solution pH 2.3

CaF2 formation and tin compounds

SHORT TERM REACTION

$$Ca_{10}(PO_4)_6(OH)_2 + 20F^- \longrightarrow 10\,CaF_2 + 6PO_4^{3-} + 2OH^-$$

Fluoroapatite, Tin oxide,
Tin hydroxide, Tin hydroxyphosphate

[Metallic taste]

LONG TERM REACTION(MORE THAN 8 MINS)

$$Ca_{10}(PO_4)_6(OH)_2 + 19SnF_2 \longrightarrow Sn3F3PO4 + CaF2 + SnO.H2O$$

(Tin tri fluorophosphate – tooth structure stable)

$$Ca_{10}(PO_4)_6(OH)_2 + 19SnF_2 \longrightarrow 6Sn3F3PO4 + 10CaF2 + SnO.H2O$$

Hydrated stannous oxide – accumulates on surface & inhibits further diffusion into enamel

↑Tin conc with time ≠ ↑Tin penetration

Originally deposited colourless compound → dark coloured stannous sulphide

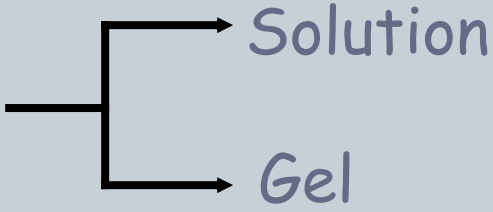
Aqueous solutions not stable

$$Sn^{+2} + 2OH^- \rightarrow Sn(OH)_2$$

$$Sn(OH)_2 \rightarrow SnO + H_2$$

ACIDULATED PHOSPHATE FLUORIDE

- Brudevold et al developed APF formula in 1960s at Forsyth Dental Centre,Boston,Massachussets.



- **APF solution :**

- Method of preparation :
- 20 gms of NaF is dissolved in 1 litre of 0.1M phosphoric acid
- To this, 50% hydro fluoride acid is added to adjust the pH at 3 & fluoride conc at 1.23%

Technique of application :(Brudevold tech)

- Prophylaxis
- APF solution is continuously and repeatedly applied with cotton applicators
- Teeth are kept moist for 4 min (i.e. Reapplication every 15-30 sec)
- Floss is passed through interproximal embrasures to ensure wetting of these surfaces
- Repeated for remaining quadrant
- Instructed not to drink, eat or rinse for 30 min

- No. of applications : 1 or 2 per year

- Advantages :
  - Stable & Cheaper
  - Does not produce staining
- Disadvantages :
  - Teeth must be kept wet for 4 min
  - Acidic, sour and bitter to taste
  - Repeated or prolonged exposure of porcelain or composite restorations to APF can result in surface roughening & possible cosmetic changes
  - 28% reduction of dental caries

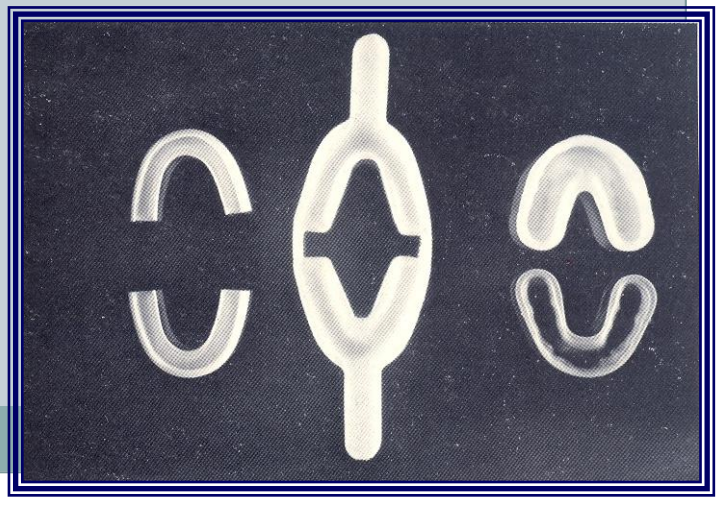
- **APF Gel**

Method of preparation :

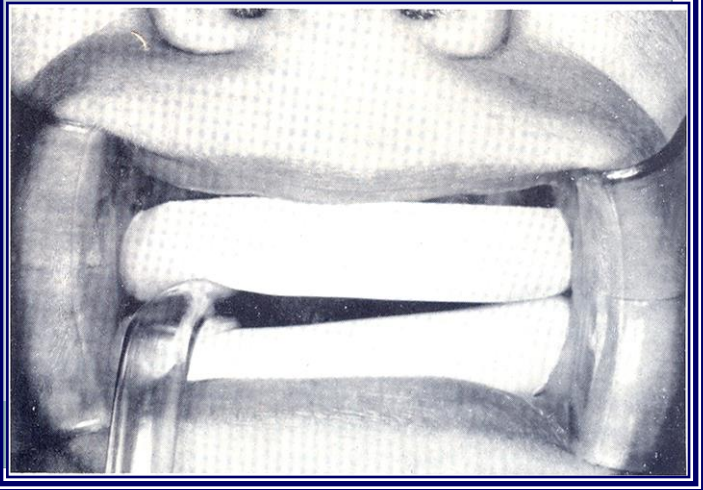
- A gelling agent methylcellulose or hydroxyethyl cellulose is to be added to the solution and pH is adjusted between 4 – 5

Technique of application :

- Prophylaxis
- Application of APF gel is done using trays that fit patients' U/L dental arches
- A disposable foam-lined tray is preferred
- Pt is seated upright in chair
- Minimum amt of APF gel should be dispensed in tray – <5 ml; Custom fitted trays –1 ml
- Saliva ejector to be used



- U/L trays are inserted into the mouth and pt is asked to exert slight pressure using light biting forces in order to cause the gel to flow interproximally
- The gel is kept in mouth for 4 min
- Instructed not to drink, eat or rinse for 30 min



- Advantages :
  - Acceptable taste due to flavoring
  - Easy to apply
  - Can be self applied → Reduced cost
  - Only 2 applications/year

- Disadvantages :
  - Irritation to gingiva and to open carious lesion

Mechanism of action :

$$Ca(PO_4)_3OH + 4H^+ \longleftrightarrow 5Ca^{++} + 3HPO_4^{--} + H_2O$$

[hydroxyapatite] [dehydration & shrinkage]

$$Ca^{++} + 3HPO_4^{--} \longleftrightarrow Ca.HPO_4.2H_2O \text{ (DCPD)}$$

[hydrolysis] [Di calcium phosphate dihydrate] (intermediate product)

$$5Ca.HPO_4.2H_2O + F^- \longleftrightarrow Ca_5(PO_4)_3F + 3HPO_4^{--} + H^+ + H_2O$$

(DCPD) [fluorapatite]

MOA of Acidulated Phosphate Fluoride

Application annually/ semiannually

↓

Require large amount of F deposited in enamel within short time

↓

High F concentration; low pH – favours F deposition

↓

Clinical trial showed contrary results with acetic acid and HF

↓

Brudevold et al- Adverse effect was due to particular acid

↓

But phosphoric acid suppressed enamel dissolution and CaF_2 formation

↓

Therefore provide more effective treatment

1.2% F from NaF + 0.1 M Phosphoric acid at 3.2 pH; later pH=4

MOA of Amine Fluoride

Developed to utilize protection of both fluoride ions and long chain amines

↓

Reduction of enamel solubility, better than stannous fluoride

Fluoride deposition occurs primarily by formation of calcium fluoride

↓

Different from those formed by NaF, because of adsorption of amine moiety

Amine portion – surfectant & antimicrobial properties(supress plaque glycolysis)

Comparison of Topical Fluoride agents

	NaF	SnF2	APF
Percent F	2%	8%	1.23%
ppm F	9,200	19,500	12,300
Frequency of application	4 weekly intervals at 3,7,11,&13yrs	1or 2/yr	1 or 2/yr
Taste	Bland	Disagreeable	Acidic
Stability	Stable	Unstable	Stable
Tooth pigmentation	No	Yes	No
Gingival irritation	No	Occasional transient	No
Average effectiveness	29%	30%	28%

Professionally administered applications of fluoride solutions

Knutson's technique

Surface of each tooth wetted
Allowed to dry for 3-4 minutes
4 applications at weekly interval
3,7,11,13

Muhler's single application technique

Mercer and Muhler's technique

Teeth kept moist for 4 minute
Biannual application

Dubbing and Muhler's technique

Teeth kept moist for 30 second

Englander technique

Prophylaxis with stannous fluoride
4 minute application
Unwaxed floss used interproximally

Szwejda – Knutson multiple chair technique

Applied in special maxillary & mandibular mouthpieces
Made from sheets of thermoplastic vinyl resin
Application for 3 minutes thrice a week

Same as Knutson
Time taken per child was reduced

Methods of application of topical fluoride

- Paint on technique
- Tray technique
- Spray application

De Paola 1967
Not recommended

Paint-on Technique

1. Prophylaxis using a rotating rubber cup & dental prophylaxis paste
2. Interdental flossing using unwaxed dental floss
3. Rinsing the mouth
4. Isolation of teeth using cotton rolls; Saliva absorbers & ejectors may also be used
5. Isolated teeth are dried with compressed air
6. Fluoride is applied using cotton-tipped applicators
7. Solution is continuously reapplied keeping the isolated teeth moist for 4 min. During this time, unwaxed dental floss soaked in fluoride solution, is passed interproximally
8. Same procedure is repeated for each quadrant or the other half of the mouth
9. After treatment the patient may expectorate, but is instructed not to rinse, eat or drink for half hour.

Tray Technique

- 1st 5 steps are same as paint-on technique
- Ribbon of fluoride gel is placed in each of the 2 trays which are inserted over upper & lower teeth & a saliva ejector is inserted
- Trays are left in place for approx 4 min

Acidulated Phosphate Fluoride Gel

First published clinical trial on APF Gel (Szwejda 1967)

APF Gel -50% caries reduction (Bryan & Williams1968)

(Ingraham & Williams1970)

APF Gel = 2 x APF Soln

First longest duration APF study comparing gel and soln – Hawaii 681, ten- twelve year old children for 3 years (Horowitz&Doyle1971)

Greatest reduction was obtained through APF Soln rather than APF Gel

Thixotropic solution

High viscosity under storage, fluid under shearing force

Stable at lower pH

FLUORIDE VEHICLE

Vehicle of fluoride incorporation can influence the level of clinical effectiveness

Fluoride Vehicles

- Aqueous solutions – First principal vehicle, Time-consuming, Costly but most consistent results
- Fluoride gels
- Fluoride containing prophylaxis pastes & cups
- Foam
- Fluoride varnishes
- Sequential Fluoride Rinses

Advantages

- Adheres to teeth for longer time
- Trays used to treat quadrants simultaneously
- Hazard of accidental ingestion is reduced

Disadvantages

- All surface covered?
- Gentle pressure maintained for approximal area

Topical Fluorides Solutions

Neutral Sodium Fluoride Solution

0.1% NaF soln – 7-8mins – thrice/year – 45% reduction (Bibby 1941)

Clinical Trial Series – 2%NaF – 3 mins -4.9% to 50%(Knutson 1942)

Stannous Fluoride Solution

Considered– most effective (Buonocore & Bibby 1945)

SnF2 > PbF2 = NaF (Muhler & van Huysen 1947)

8% SnF2- apply continuously to teeth – every 30 sec for 4 mins

Reduction – 28%- 51%

Disadvantage –gingival irritation, brown pigmentation of teeth, to be prepared fresh each time

Acidulated Phosphate Fluoride Solution

Lesser the pH; more F absorption into enamel (Bibby 1947)

Prolonged exposure of enamel -NaF in acid $NaPO_4$ (Brudevold1963)

1.23% of available F in 0.1M phosphoric acid at pH 3

First clinical trial – Wellock& Brudevold 1963

Bitewing radiographs were used to aid in diagnosis

Continuously applied after every 30secs for 4 mins

Overcome – wax & plastic trays soaked in F soln to be applied to teeth

Later – gelling agent was introduced & removed blotting paper inserts (methyl cellulose, hydroxyethyl cellulose)

Fluoride Gels

- APF is commercially available as gel
- Formulation is same as aqueous solution except for the addition of gelling agent (Alkyl cellulose etc)
- Advantages:
  - Can be used in trays so that the entire mouth can be treated simultaneously
  - Easier & less time-consuming

Fluoridated prophylactic pastes

Significant amount of enamel lost(4µm) – prophylaxis
Undesirable loss – surface enamel has highest conc of F

F compounds have been incorporated into prophylactic pastes

Agents incorporated

Sodium Fluoride
Stannous Fluoride
Acidulated Phosphate Fluoride
Stannous Hexafluorozirconate

Fluoridated prophylactic pastes

Pastes containing Sodium Fluoride

Bibby et al 1946 evaluated 1% NaF & Pumice

Reported caries increment reduction- 25%-43%

Pastes containing Stannous Fluoride

Significant enamel solubility reduction- SnF2-pumice

SnF2 – silicone ≈ 8% SnF2 solution

No preventive effect Mericle and Muhler (1963)

SnF2 – Zirconium Silicate – superior Horowitz and Lucey (1966)

School based preventive program, California involved

annual "brush-ings" – inconclusive – Zircate(market) Muhler et al (1964, 1970)

SnF2 – insoluble metaphosphate Horowitz and Bixler (1976)

Mellberg and Nicholson(1968)

Pastes containing Acidulated Phosphate Fluoride

Freshly prepared APF- lava pumice applied annually

2.1% F ions, minimal caries inhibition, attributed to neutralization of APF

Pastes containing Tin Hexafluorozirconate($SnZrF_6$)

Reduce enamel solubility (Shannon 1969)

Irritation, gingival inflammation, frank necrosis (Horowitz & Heifetz 1970)

Fluoride containing prophylaxis pastes

- Allows the practitioner to provide both cleaning & fluoride application in one step
- Easy & Time saving but not widely used
- Use of incompatible abrasives (Pumice), high concentration of humectants (Glycerol) or high viscosity greatly reduces or inhibits fluoride uptake by enamel
- The first marketed product contained SnF_2 as the active ingredient & zirconium silicate as the abrasive
- Other abrasives used: Silicon dioxide

Fluoride impregnated prophylaxis cup

- Prophylaxis cups made from a blend of thermoplastic resins and impregnated with NaF & SnF_2 will increase the fluoride content of enamel & will increase the resistance of treated surfaces to acid dissolution

- However, amount of fluoride deposited in enamel when a fluoride containing prophylaxis paste is used was generally found to be similar whether a conventional or F impregnated prophylaxis cup was used.

Sequential Office-rinse method

- Initially: 0.31% APF solution (3100ppm F) followed by a 0.4% SnF2 solution (1000ppm F)

- User is offered a choice:

  - Two 1-min rinses with APF followed by two 1-min rinses with SnF2

  - Two 1-min rinses with a combined solution of APF & SnF2

Fluoride Foam

- To minimize risk of fluoride overdosage & to maintain efficacy of topical fluoride treatment
- Wei at al (1988) : Topical application of APF foam significantly increased F concentration in outer 5mm of enamel
- Much lighter than gel → Less amount required (4gm gel/mouth; 1gm foam/mouth)
- No suctioning required → Home use as well & for treatment of young & disabled children
- Surfactant in foaming agent has a cleansing action by lowering ST → Facilitates penetration of material into interproximal surfaces

- **Fluoride varnish**

- Discovered by Schmidt in 1964
- After topical fluoride application, there is substantial leaching of absorbed fluoride from surface enamel. To prevent this immediate loss, fluoride has been incorporated into varnishes that have the ability to adhere to enamel for longer periods & it is hypothesized to slowly release the fluoride to teeth
- Commercially available
- Recommended application: Biannual
- Duraphat, Fluorprotector, Fluoritop, Duraflor

Fluoride varnishes

1) Duraphat : (ICN Pharmaceuticals,Eschwege, FRG)
   - 1st Fluoride varnish in Germany
   - Viscous yellow material containing 22600ppmF as NaF in a neutral colophonium base (NaF varnish containing 2.26% F in organic lacquer)

2) Fluorprotector

   Clear polyurethane based product containing 7000 ppm F from an organic compound difluorosilane (Organic silane fluoride with 0.7% F equivalent to 0.32% F in a polyurethane based lacquer)

3) Carex

   Contains lower fluoride conc than Duraphat (1.8% F)

FLUORIDE VARNISH

2/3 F acquired is lost within days
Richardson – water proofing coat

30%- 40%- 2°
7%- 44%-1°

First, Germany,
Viscous yellowish

DURAPHAT

22600 ppm NaF in neutral colophonium base

FLUOROPROTECTOR

Polyurethane based product containing 7000ppm F from an organic compound, diflurosilane

1%- 17%

CAREX

1.8% F conc

FLUOR PROTECTOR

Polyurethane lacquer dissolved in chloroform and difluorosilane at a concentration of 2% by weight equivalent to 0.32% fluoride in the liquid.

Dispensed in 1 ampule – 6.21 mg of fluoride

Invivo tests

1600 ppm – 1 week after single application

2800ppm – 1 week after second application

6 months – 70%-50% of acquired F lost

Bruun et al 1980

Varnishes are superior to APF in depositing fluoride in sound enamel

Role of varnishes in school- based programs

Krkegaard et al 1986

Semi-annual application of duraphat

Fortnightly rinsing – 0.2% neutral NaF solution

Similar caries reduction

Technique of application :

- Prophylaxis & Interproximal flossing
- Teeth dried with air
- No isolation with cotton rolls
- A drop of varnish is taken on brush and painted thin on the teeth
- Painted first on lower arch & then on upper arch [0.3-0.5 ml (6.9-11.5 mgF)]
- The varnishes harden in approx 2 min
- Pt is made to sit with mouth open for 4 min
- Pt is instructed not to rinse or drink or brush teeth for 1 hour
- Pt is instructed to take liquids or semisolid food and avoid eating solid food till next morning

- Time for application: 5-6min

- No. of application :
  - Semiannual application

- Advantages :
  - Forms a water tight protective film insulating against thermal and chemical influences
  - Varnish remains on tooth for longer duration

- Disadvantages :
  - Patient co-operation is required
  - Expensive

Professional fluoride varnish treatment for caries control: a systematic review of clinical trials.

- Aim – evaluate systematically caries preventive effect of professional fluoride varnish treatments
- Literature search – 1966 and Aug 2003
- Out of 302 identified papers, 24 randomized and controlled clinical trials comparing fluoride varnish with placebo, no active treatment or other fluoride preventive regimens for at least 2 years study duration were included.
- Assessed independently by 2 examiners
- Outcome measure – preventive fraction expressed as %

Peterson LG et al. Professional fluoride varnish treatment for caries control: a systematic review of clinical trials. Acta Odontol Scand 2004; 62: 170-76

Results

Limited evidence (evidence level 3)

Caries preventive effect of topical application of fluoride varnishes in permanent teeth (Av PF- 30%) when compared with untreated control

Inconclusive evidence (evidence level 4)

Fluoride varnish treatment in the primary dentition & in adults

Reinforces the need for future clinical research of high quality incorporating modern concepts of clinical performance and evaluation to assess dental caries control using professional fluoride varnish

Peterson LG et al. Professional fluoride varnish treatment for caries control: a systematic review of clinical trials. Acta Odontol Scand 2004; 62: 170-76

Evaluation of suction device on reducing oral Fluoride retention

Although suction device significantly reduced the amount of fluoride retained, the subjects still retained, on an average, from 6- 15 mg of fluoride following the suctioning procedure

More et al 1983, Elsen & Lecompte 1985, Lecompte & Doyte 1985

SLOW RELEASE SYSTEMS

Devices applied to the teeth, usually molars, that release low level of fluoride for prolonged period

- Slow release lozenges
- Bioadhesive tablets

Two types of intraoral fluoride slow-release device are currently in use

- The copolymer membrane (Cowsar 1976)
- Slowly dissolving fluoride glass beads (Toumba 1993)

Glass beads- 4 mm(Diameter)- attached - molar - acid-etch composite

The percentage of incorporated fluoride can be adjusted to vary the amount released and have been shown to lead to raised salivary fluoride levels for up to 2 years (Toumba 1993).

Bonner BC, Clarkson JE, Dobbyn L, Khanna S. Slow-release fluoride devices for the control of dental decay. *Cochrane Database of Systematic Reviews 2006, Issue 4. Art. No.: CD005101. DOI: 10.1002/14651858.CD005101.pub2.*

Slowly dissolving fluoride-releasing glass beads may help reduce dental decay if retained in the mouth over time, but retention of the beads is a problem

Concludes that slow-release fluoride devices have potential to protect against tooth decay

If they can be kept in mouth for 2 years

Weak and unreliable

A single study reported - reduction of 0.72 in mean caries increment compared to control

However, this analysis excluded 52% of available participants, whose beads had become dislodged.

Bonner BC, Clarkson JE, Dobbyn L, Khanna S. Slow-release fluoride devices for the control of dental decay. *Cochrane Database of Systematic Reviews 2006, Issue 4. Art. No.: CD005101. DOI: 10.1002/14651858.CD005101.pub2.*

Intraoral Controlled Release Device for Fluorides

- A fluoride containing copolymer matrix is encapsulated by copolymer membrane that controls the rate at which F ions from the core diffuse into oral environment
- CRFD can be made to release predetermined quantity of F (eg 1 mg/day) over a period of months
- CRFD can elevate salivary F conc from 0.02 ppm to 0.2 – 0.3 ppm for up to 100 days
- Mean plaque conc can be raised from 10 – 15 ppm to 35 – 55 ppm

Intraoral Controlled Release Device for Fluorides

- ***Copolymer membrane device:***

- *Developed by Cowsar et al*
- *Consists of a small pellet which could be attached on or near the tooth surface.*
- *Designed as a membrane-controlled reservoir-type and has an inner core of hydroxyethyl methacrylate (HEMA) / methyl methacrylate (MMA) copolymer (50:50 mixture), containing a precise amount of sodium fluoride (NaF). This core is surrounded by a 30:70 HEMA/MMA copolymer membrane, which controls the rate of fluoride release from the device*
- 8 mm in length, 3 mm in width and 2 mm in thickness

❑ Copolymer Membrane Device:

Depending on the amount of F in the inner core, the rate of F release of these devices can be between 0.02 and 1.0 mg F/day for up to 180 days.

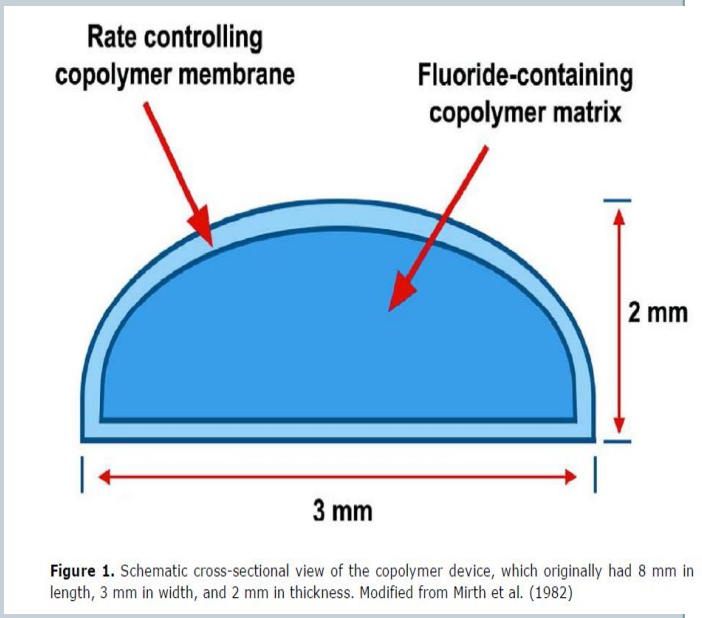


Figure 1. Schematic cross-sectional view of the copolymer device, which originally had 8 mm in length, 3 mm in width, and 2 mm in thickness. Modified from Mirth et al. (1982)

Intraoral Controlled Release Device for Fluorides

Glass Device:

- The F glass device dissolves slowly when moist in saliva, releasing F without significantly affecting the device's integrity.
- The original device was dome shaped, with a diameter of 4 mm and about 2 mm thick being usually attached to the buccal surface of the first permanent molar using adhesive resins
- Due to the low retention rates of the original device, it was further substantially changed to a kidney-shaped device, being 6 mm long, 2.5 mm in width and 2.3 mm in depth and it was proven to be effective regarding both F release and retention rate

Intraoral Controlled Release Device for Fluorides

Glass Device:

- A new modification was introduced more recently, in order to facilitate device handling, attachment and replacement. This new device has been shaped in the form of a disk that is placed within a plastic bracket so that a new device can be easily installed without the need for de-bonding, removing remnants of composite resin and performing a new acid etch and bonding the device
- Devices containing 13.3% F showed a higher rate of F release compared to devices containing higher F concentrations (18.3% and 21.9%); this was explained by the presence of Aluminum in the high F concentration devices, which binds to F thus reducing its release rate.
- Longer lifetime, releasing F continuous for up to 2 years

Figure 2. Original glass device attached to the buccal surface of the first upper right permanent molar

Figure 3. Kidney-shaped device bonded to the upper first

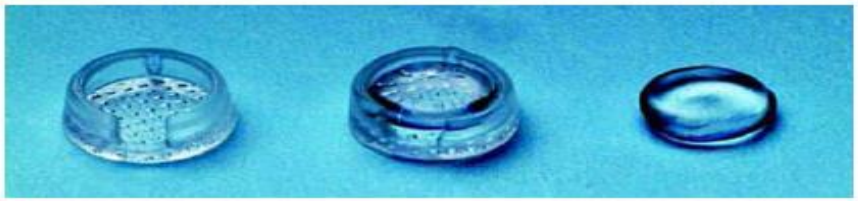


Figure 4. The latest version of the fluoride glass slow release device and plastic retention bracket

Figure 5. Latest glass device and bracket attached to upper first permanent molar tooth

Fluoride containing Alginates

- Commercially available alginates --- De trey's, Zelgan, Kerr contain 1.9% & 1.5% F
- They do furnish topical F exposure to pts who require prosthodontic or orthodontic Rx
- They provide limited additional cariostatic benefits of a very short duration

FLUORIDE CONTAINING RESTORATIVE MATERIAL

- Amalgam (Fazzi 1977),
- Acrylic plates (Harary1984),
- Cements (Masuhara 1985),
- Resins (Cooley 1988),
- Sealants(Cooley 1990),
- Fluoride-releasing elastomerics (Banks 2000),
- Glass ionomer cements (Hatibovic 1991).

Desired properties of fluoride-releasing devices (Toumba 2001), from this list, only glass ionomer cements meet the criterion of long-term fluoride release of at least 1 year.

Fluoride containing restorative materials

- Silicate Cement :
  - Reduce enamel solubility
  - Fluoride is incorporated during the manufacturing process & can be present in concentrations as high as 130000ppm

- Zinc phosphate cement :
  - Containing 10% SnF_2: cause significant higher F uptake by enamel

- Zinc oxide eugenol cement :
  - NaF, SnF_2 can be incorporated in ZOE
  - Significant reduction in enamel acid solubility
  - As it is used as temporary & intermediate restorative material, added F has got great value

- Carboxylate cement :
  - Used with crowns and orthodontic bands
  - Have high tensile bond strength & high acid insolubility
  - Bond to enamel through chelation reaction process
  - 10% MFP reduced enamel solubility

- Glass ionomer cement :
  - Used as luting agent, class V restorations
  - Adheres to enamel and dentin by physicochemical bonding
  - Matrix of GIC contains sheathed droplets of cal fluoride in a siliceous hydrogel
  - The slow leaching of F from this matrix imparts anticaries benefits
- Amalgam :
  - Jerman --- added 1.5% of SnF_2 to silver amalgam alloy
  - Enamel surfaces in contact with fluoride containing amalgam showed significant reduction in acid solubility
  - Have higher corrosion than non-fluoridated restoration
  - Significant drop in compressive strength

- Cavity Varnishes & Liners:
  - Calcium monofluorophosphate, Potassium Fluorozirconate, NaF or Amine fluoride have been added
- Composite resins, Silicophosphate cements : Similar studies have been performed

FLUORIDE CONTAINING DENTAL DEVICES

- Fluoride impregnated dental floss

3 times more F than with plain dental floss

Sigmificant reduction S Mutans count

Twice-daily flossing regimen difficult to follow

- Fluoride impregnated prophylaxis cup

Temp of enamel raised during prophylaxis

Enhance F uptake

Prophylaxis cups – thermoplastic resin and impregnated with NaF and SnF_2

Fluoride Treatment of Avulsed Tooth

Emergency situation in dental clinic – traumatic avulsion of anterior tooth

Recommended to replant as soon as possible

Bad prognosis – external resorption of root – eventually lost

Immersion of extracted teeth in F solutions will greatly inhibit root resorption following replantation

Immersion increases amount of F in cementum

F released to adjacent alveolar bone may inhibit osteoclastic activity in the surrounding bone.

Method of enhancing fluoride fixation in enamel

- Increase in frequency of application and time exposure
- Pretreatment of enamel surfaces
- By acidified, saturated solution of dicalcium phosphate dihydrate
- Use of complexing agent

Increase enamel surface area
Enhance fluoride uptake
Pretreatment with DCPD
(Chow et al 1981)

Elevated F levels associated with higher Al conc
Pretreatment with 1.0 M AlNO3 increased F deposition by 6 times
Fluoride -Aluminium complex is formed
Clinical trial suggested that complex was ineffective in caries inhibition
(Mc Cann 1969)

P & F Sealants and Topical Fluoride application

- Topical fluoride treatment should not be performed on occlusal surfaces either immediately before acid conditioning or between acid conditioning and sealant placement.

- Topical Fluorides react with conditioned enamel to form globular reaction products (possibly amorphous calcium fluoride) which significantly reduce the bond strength between sealant & enamel surface.

Self Applied Topical Fluoride

Self application procedures of topical fluoride

All intended for daily use

Contains comparable amount of fluoride

Dentition exposed to 0.5 – 3.4mg F each time used

Self applied topical Fluorides

- Dentifrices
- Gels
- Mouth rinses
- Floss
- Chewing gums
- Toothpicks

Fluoride Dentifrices

- The development of fluoride dentifrice began around 1945
- The first clinical trial of a fluoride dentifrice was initiated by Bibby in 1942 : It contained NaF added to a dentifrice containing Dicalcium Phosphate as abrasive
- 1955 – SnF2 dentifrices – 1st fluoridated dentifrice recognized by FDA
- 1st fluoride dentifrice was accepted by ADA in 1964
- Crest, the first commercially available fluoride-containing dentifrice in the United States, was marketed by Procter & Gamble in 1955. This product originally contained stannous fluoride (SnF2), but the formulation was later changed to sodium fluoride (NaF). Colgate-Palmolive began marketing Colgate with MFP (monofluorophospate) in 1967

Ingredient	Percentage
Abrasives	20 – 40
Water	20 – 40
Humectants	20 – 40
Foaming agent (soap or detergent)	1 – 2
Binding agent	2
Flavoring agent	2
Sweetening agent	2
Therapeutic agent	5
Coloring or preservative	1

1955 stannous fluoride dentifrice – 1st by FDA

First Fluoride dentifrice accepted by ADA in 1964

Active agent- Stannous Fluoride
Abrasive – Calcium Pyrophosphate

Early clinical trials

Bibby 1942

Active agent – NaF
Abrasive – DCP
No significant caries reduction

Muhler et al 1954

Fresh ground with calcium abrasive

Sodium monofluorophosphate

Torell and Ericson 1965

Zacherl 1981

NaF with SiO_2

Functions of fluoride dentifrices

Therapeutic function

- Physico mechanical
- Chemical function

2- Fluoridated Toothpastes

They are considered as one of the most common forms of topical fluorides.

In addition to the abrasive and flavoring agent, f is added to the toothpaste as the preventive (therapeutic) agent

The toothpaste usually contain about 1000 to 1100 ppm of f, and has offered 15% to 30 % reduction in dental caries

Young children should be supervised during brushing to avoid excessive f consumption

Composition of dentifrices

ABRSASIVES

Degree of abrasivity and compatibility with fluoride

Calcium abrasives – inactivate fluorides

DCP ~~heat treatment~~ → Calcium Pyrophosphate - SnF_2, NaF

Insoluble Sodium Metaphosphate $(NaPo_3)_x$

Calcium Pyrophosphate $(Ca_2P_2O_7)$

Dicalcium Phosphate Dihydrate / Anhydrous

Calcium Carbonate (CaCo3)

Aluminium Trihydrate

Silica

Sodium Bicarbonate

Plastic particle(PMMA) "BOFORS"

- **Abrasives in Fluoride Dentifrices:**
  - The most important factors in selecting a particular abrasive for a fluoride containing dentifrice are its degree of abrasivity to dental hard tissues & its compatibility with fluoride.
  - Abrasivity must be sufficient to remove & prevent buildup of stain but mild enough so that the enamel or exposed root surfaces are not harmed.
  - Abrasives vary widely in fluoride compatibility; All calcium-containing abrasives have the potential to inactivate fluoride. Inactivation can occur through reactions forming calcium fluoride or fluorapatite, by adsorption to abrasive surface, or by complexing with soluble ions.

- **Abrasives in Fluoride Dentifrices:**
  - The compatibility of calcium containing abrasives has been improved by modification of their physical & chemical forms.
  - Eg: Heat t/t of dicalcium pyrophosphate increased its compatibility sufficiently to allow its use in SnF_2 & NaF dentifrices.
  - Fluoride compatibility with abrasives is also greatly enhanced when sodium monofluorophosphate is used as fluoride source.

- **Abrasives in Fluoride Dentifrices:**
  - The most common abrasives used in dentifrices are the following:
    - Insoluble sodium metaphosphate: Compatible with fluoride
    - Calcium pyrophosphate: One of the most inert calcium phosphate abrasives used in NaF, SnF_2 & sodium monofluorophosphate dentifrices
    - Dicalcium phosphate dihydrate: Compatible with Sodium
    - Calcium Carbonate (Chalk): Monofluorophosphate only
    - Aluminium trihydrate:
    - Silica: Used in clear gel formulations b[illegible] their index of refraction can be matched by liquid phase of dentifrice
    - Sodium bicarbonate: Compatible but not usually used in fluoride dentifrices
    - Plastic particles (Polymethylmethacrylate): Used in Swedish dentifrices (Bofors) – Compatible with all types of fluorides used in dentifrices

HUMECTANTS

Laboratories studies- reduce amount of F taken up by enamel

Effect lessened by dilution with saliva

SURFECTANTS

$Na_2PO_3F + H_2O \xrightarrow{\text{hydrolysis}} NaOH + H^+ PO_3F^-$

Hydrolysis occurred few minutes after tooth brushing Nelson and Roll 1983

Reduction in plaque growth Brunn et al 1984

Inhibited CaF_2 formation Schmid et al 1984

- **Fluoride source in Fluoride dentifrices:**
  - Sodium Fluoride
  - Sodium monofluorophosphate
  - Stannous Fluoride
  - Amine Fluoride: Used in European countries
  - Potassium fluoride & Ammonium fluoride : Not of major significance

  - The standard F concentration in all major dentifrices in US is 0.1% (1000ppm). This is equivalent to 0.22% NaF, 0.76% sodium monofluorophosphate & 0.4% SnF_2
  - In Europe, some dentifrices may contain upto 1500 ppm F

- Types of fluoride dentifrices
  1) NaF dentifrices
  2) SnF2 dentifrices
  3) Monofluorophosphate dentifrices
  4) Amine fluoride dentifrices
  5) Hexafluoro zirconate dentifrices

Sodium fluoride dentifrice :

- Ericsson (1961) --- checked compatibility of F compounds with conventional tooth paste and reported that abrasive system of cal. carbonate & phosphate inactivates NaF by formation of cal. fluoride
  - Recommended --- sodium bicarbonate : 18% caries inhibition
  - NaF --- insoluble sodium metaphosphate or plastic abrasives: Caries inhibition --- 9 – 48%
- Calcium pyrophosphate:11 – 38% caries inhibition

- FDA (1973) approved NaF dentifrice formulated with Calcium pyrophosphate abrasive system. FDA proposed rules for NaF dentifrice are 0.1888 to 0.254% with available F concentration of 650ppm

Fluoride compounds in dentifrice

SODIUM FLUORIDE DENTIFRICES

First fluoride incorporated in conventional toothpaste

Bibby 1945, 0.1%NaF + $CaCO_3$

Winkler 1953, 0.15%NaF + $CaCO_3$

Muhler 1955, 0.22%NaF + Ca pyrophosphate

Kyes 1961, 0.2%NaF + insoluble sodium metaphosphate

No statistically significant results

Torell and Ericsson 1965, 0.2%NaF + $NaHCO_3$

0.22%NaF + Acrylic particles - low in abrasivity but max^{m} of free ionized fluoride

FDA 1973 – NaF + Ca pyrophosphate (650ppm)

ACIDULATED PHOSPHATE FLUORIDE DENTIFRICE

Large amount of fluoride were deposited from high concentrations at a low pH

BRUDEVOL D 1963

- **Stannous fluoride dentifrices:**
  - Early work conducted in early 1950s by Muhler & his associates at Indiana University in conjunction with the manufacturer of commercial product, Crest

    SnF_2 + calcium pyrophosphate
  - Abrasive used in Crest was calcium pyrophosphate
  - "CREST PLUS" - SnF_2 + silica
  - In early 1960s, several SnF2-insoluble sodium metaphosphate dentifrices were marketed (Cue, Fact, Super Stripe)
  - Aim: Recently marketed clear gel SnF2 dentifrice based on SnF2-Silica abrasive system in which fluoride is more stable than in SnF2-Calcium pyrophosphate system
  - Disadvantages: Tooth pigmentation (Staining), chiefly in thick pellicle or chalky, porous enamel of incipient lesions , Low pH & high conc of **Sn^{-}**– metallic, astringent taste

Sodium Monoflourophosphate dentifrice :

- First commercial dentifrice to be developed containing Sod. MFP utilized insoluble metaphosphate as abrasive –Colgate Dental Cream with MFP
- The most widely used fluoride source for dentifrices throughout the world.
- Produced during 1940's in the research laboratories of Ozark Mahoning company in Tulsa, Okalahoma
- Advantages: Much greater compatibility with common dentifrice abrasives & lack of tooth staining

SODIUM MONOFLUOROPHOSPHATE DENTIFRICE

Fluoride effect

Intracrystallite transposition - deposited Sodium Monofluorophosphate and hydroxyapatite group (Ericsson 1963, Gron et al 1971)

Monofluorophosphate effect

MFP ion incorporated in the crystal lattice by exchange with phosphate group in enamel (Ingram 1972)

"Carry over protection" (Hargreaves et al 1974)

0.76%NaMFP - Original Colgate

0.76%NaMFP+ 0.1%NaF – Colgate Dental Cream

Doesn’t occur in nature

1 atom P, 1 atom F, 3 atom oxygen

Interesting property

SMFP + Ca Abrasive – Ca MFP (soluble)

NaF + Ca Abrasive – CaF2(insoluble precipitate)

SMFP and insoluble sodium metaphosphate

Amine fluoride dentifrice :

- First tested for its cariostatic potential in Zurich, Switzerland
- Surfactant & antibacterial properties; Reduces enamel solubility
- Elmex (GABA Int Basel, Switzerland) --- Contains 0.125% Fluoride with an insoluble sodium metaphosphate as the abrasive – First marketed in Switzerland in 1963

More effective than Sodium Monoflourophosphate or sodium fluoride Superior (enamel solution rate reduction, F uptake, antiglycolytic

activity in plaque)

- Unpleasant taste
- Foams less than Sodium monofluorophosphate dentifrice
- Only in few countries in Europe, not in US

Table 8-6 Fluoride dentifrices accepted by the American Dental Association

Dentifrice	Manufacturer	Fluoride source	Abrasive
Crest*	Procter & Gamble Co.	SnF_2	$Ca_2P_2O_7$
Colgate with MFP*	Colgate-Palmolive Co.	Na_2PO_3F	IMP
Macleans Fluoride	Beecham Products, Inc.	Na_2PO_3F	$CaCO_3$
Aquafresh	Beecham Products, Inc.	Na_2PO_3F	$CaCO_3/SiO_2$
Aim*	Lever-Brothers Co.	SnF_2	SiO_2

*After preparation of this chapter, the fluoride-abrasive composition of three dentifrices was changed as follows: Crest now contains NaF and silica, Colgate contains Na_2PO_3F and $CaHPO_4 \cdot 2H_2O$, and Aim contains Na_2PO_3F and silica.

Recommendations for use of Fluoride dentifrices

Below 4 yrs	F toothpaste is not recommended
4-6 yrs	Brushing once daily with F paste & twice with out F paste
6-10 yrs	Brushing twice daily with F paste & once with out F paste
Above 10 yrs	Brushing twice daily with F paste

RETENTION OF FLUORIDE DENTIFRICE

- Dentifrice usage
- Little post dentifrice clinical rinsing encouraged to permit maximum intraoral topical fluoride effect

ADA classification of fluoride dentifrices

- **Accepted** – adequate evidence of safety and effectiveness
- **Provisionally accepted** – reasonable evidence of usefulness and safety

  Lack sufficient evidence to justify being classified as accepted
- **Unaccepted** – no substantial evidence of usefulness exists or on question of safety.

Both laboratory and clinical evidence is considered

Ingestion o fluoride dentifrice

Age(years)	Dentifrice ingested (%)	Mean fluoride ingested(mg)
2-4	35	0.30
5-7	14	0.13
11-13	6.5	0.07
20-35	3	0.04

Barnhart et al 1974

CARIES PREVENTIVE EFFECT OF FLUORIDE TOOTHPASTE: A SYSTEMATIC REVIEW

Aim – caries preventive effect of fluoride toothpaste in various age groups, with special emphasis on fluoride concentration and supervised versus non-supervised brushing

Systematic literature search – 1966- April2003

Inclusion criteria – randomized/ controlled clinical trial, atleast 2 years follow up, caries increment in primary and permanent dentition

905 articles originally identified, 54 met inclusion criteria

Assessed by two reviewers independently- scored A-C according to predetermined criteria for methodology and performance

Twetman S et al. Caries preventive effect of fluoride toothpaste: a systematic review, Acta Odontol Scand 2003; 61:347- 355.

Caries preventive effect of fluoride toothpaste: a systematic review

Strong evidence(evidence level 1)

- PF= 24.9%, caries preventive effect of daily use of fluoride fluoride toothpaste compared to placebo in young permanent dentition
- 1500ppm had superior preventive effect compared with 1000ppm
- Higher caries reduction in supervised brushing compared to non supervised brushing (23.3%)

Incomplete evidence(evidence level 4)

Regarding the effect of fluoride toothpaste in primary dentition

Twetman S et al. Caries preventive effect of fluoride toothpaste: a systematic review, Acta Odontol Scand 2003; 61:347- 355.

Fluoride mouth rinses

- Bibby et al in 1946 : Bibby employed a 0.01% NaF solution (45ppm F) acidified at pH 4 as mouthrinse & found 28% caries reduction.
- Effectiveness – 20-50% caries reduction
- In 1975, the Council on Dental Therapeutics of ADA accepted both neutral NaF & APF mouthrinses as effective agents in reducing the incidence of dental decay
- Later, a SnF_2 mouthrinse was also accepted by ADA

✦ Rinses are recommended to be used by forceful swishing of about 10 ml of liquid between the teeth and around the mouth for 60 sec before expectorating

- **Advantages :**
  - Simple, well accepted, safe & inexpensive
  - Low conc of F are sufficient to inhibit glycolysis and acid production by plaque micro-organisms
  - Repeated exposure to low conc of F effectively promotes remineralization of incipient carious lesions
- **Indications:**
  - Recommended for persons with high caries susceptibility
  - Pts who have orthodontic or prosthetic appliance & those with medical or physical disabilities

Fluoride Mouthrinses

- Acidified NaF Mouthrinses: Bibby et al: 0.01% NaF solution (45ppm F) acidified to pH4: Negative results;
  - But later studies using higher concentrations gave positive results

- Amine fluoride mouthrinses
- Ammonium fluoride mouthrinses

Fluoride mouthrinses

- Rinse & expectorate: Commonly practised
- Swish & Swallow: teaspoonful of 0.05% NaF, if swallowed, delivers 1 mg NaF: Recommended if concentration of F in drinking water is 0.3 ppm or less & if patient is not on supplements

- FDA regulations state that fluoride rinses are not to be prescribed under the age of 6 yrs unless they are taken as systemic supplements

Fluoride mouthrinses

Use first demonstrated – Bibby1946

Widely used in caries preventive public health methods

Efficacy related to the type of fluoride compound used

APF, SnF_2,NH_4 = neutral NaF

Addition of Al,Mn,Fe,Mg,Zr,andK ions

Sodium fluoride is the compound of choice at present

Efficacy related to fluoride concentration used

Trials varied from 0.04%- 0.3%(45ppm-3000ppm)

Fluoride Mouthrinses

Fluoride mouthrinses have been available for several decades in the United States as solutions containing:

- 0.05% NaF (~225 ppm F) or acidulated phosphate fluoride (APF) for daily use {High frequency, Low potency}: Prepared by dissolving 200mg NaF tab in 5 teaspoons of fresh clean water (25ml) For a family of about 4 members
- 0.2% NaF (~900 ppm F) solutions for weekly use. {Low frequency, High potency} : 2gm NaF dissolved in 1000ml water

Both concentrations were originally available as prescription-only ingestible solutions, with the 2% formulations reserved primarily for school-based mouthrinse programs.

Fluoride Mouthrinses

- Acidified NaF Mouthrinses: Bibby et al: 0.01% NaF solution (45ppm F) acidified to pH4: Negative results;
  - But later studies using higher concentrations gave positive results

- Amine fluoride mouthrinses
- Ammonium fluoride mouthrinses

Table 9-15 Fluoride ingestion from common mouth rinses assuming 20 percent retention

Rinse Concentration (% NaF)	Amount of rinse	mg F in rinse	mg F retained at 20% retention level
0.05%*	5 ml	1 mg	.2 mg
	10 ml	2 mg	.4 mg
0.2%**	5 ml	4.5 mg	.9 mg
	10 ml	*9.0 mg*	*1.8 mg*

*Used in low potency, high frequency technique.

**Used in high potency, low frequency technique.

Efficacy related to fluoride concentration and frequency of rinsing

Little indication that increasing conc increases effectiveness

Frequency – twice /day – thrice/ year

Once a week, thrice a week, every fortnight

Duration of rinsing, quantity of rinse and swallowing

1-2 minute

10ml

< 3 years – rinsing not recommended- inadequate swallow reflexes

Sequential fluoride rinses

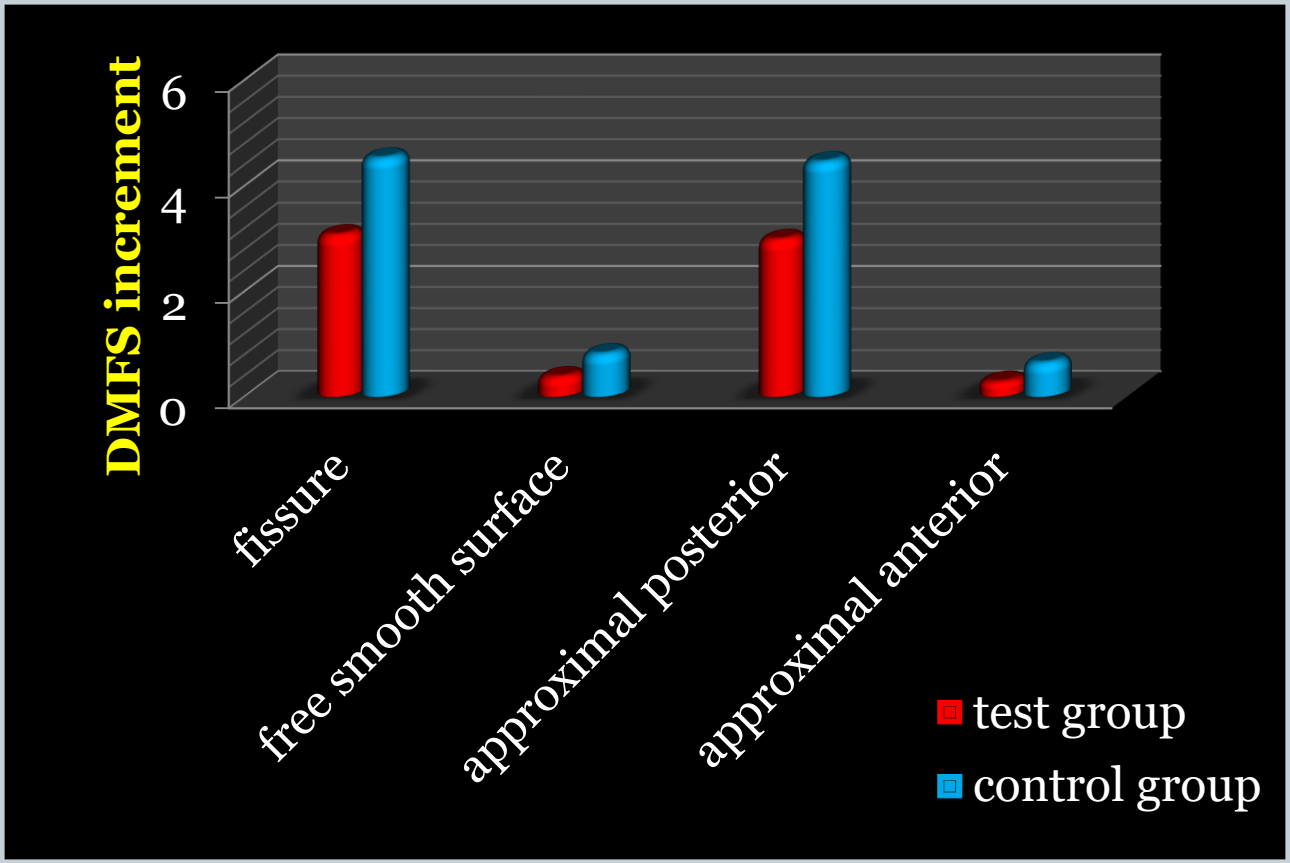
Sequential applications of APF and SnF2 to enamel produced greater protection against acid dissolution than when either of them were used alone

1.23% APF and 0.5% SnF2

No clinical trial supporting caries inhibition

Shannon 1970

Caries prevention in different teeth and type of tooth Surface



Rugg – Gunn et al 1973

Possible lack of continuing effect after rinsing ceases

Protection conferred is transitory and lost soon after rinsing ceases

Three year trial – 22 %reduction

Factors

10 years, PM, 2nd M, Upper Canine erupted

Caries increment were very high

More sound surface at risk

Test group < caries- Control Group

Koch 1967, 69

Adverse effects of mouthrinsing

Gingival inflammation – 2225 ppm

Yellow Staining

Allergy

Recommendation for fluoride mouthrinsing

Rinse and expectorate

Swish and swallow - < 0.3ppm F in water

School based F mouthrinsing program

Increased risk – orthodontic pt., radiotherapy

Caries preventive effect of sodium fluoride mouthrinse: a systematic review of controlled clinical trials

Measure of effect – preventive fraction expressed as percentage

Results

Limited evidence(evidence level 3)

Caries preventive effect (PF-29%) of daily or weekly NaF rinses compared with placebo in permanent teeth of school children and adolescents with no additional fluoride exposure and for a caries preventive effect on root caries in older adults

Inconclusive evidence(evidence level4)

Effect of FMRs exposed to additional fluoride source eg. Daily use of fluoride toothpaste

Furthermore, no association between frequency of rinsing& PF or saved surfaces per year was found.

Twetman S et al. Caries preventive effect of sodium fluoride mouthrinse: a systematic review of controlled clinical trials. Acta Odontol Scand 2004; 62:223-230

Caries preventive effect of sodium fluoride mouthrinse: a systematic review of controlled clinical trials

Aim – to report the findings of caries preventive effect of fluoride mouthrinses in various age groups

Literature search – 1966- Aug 2003

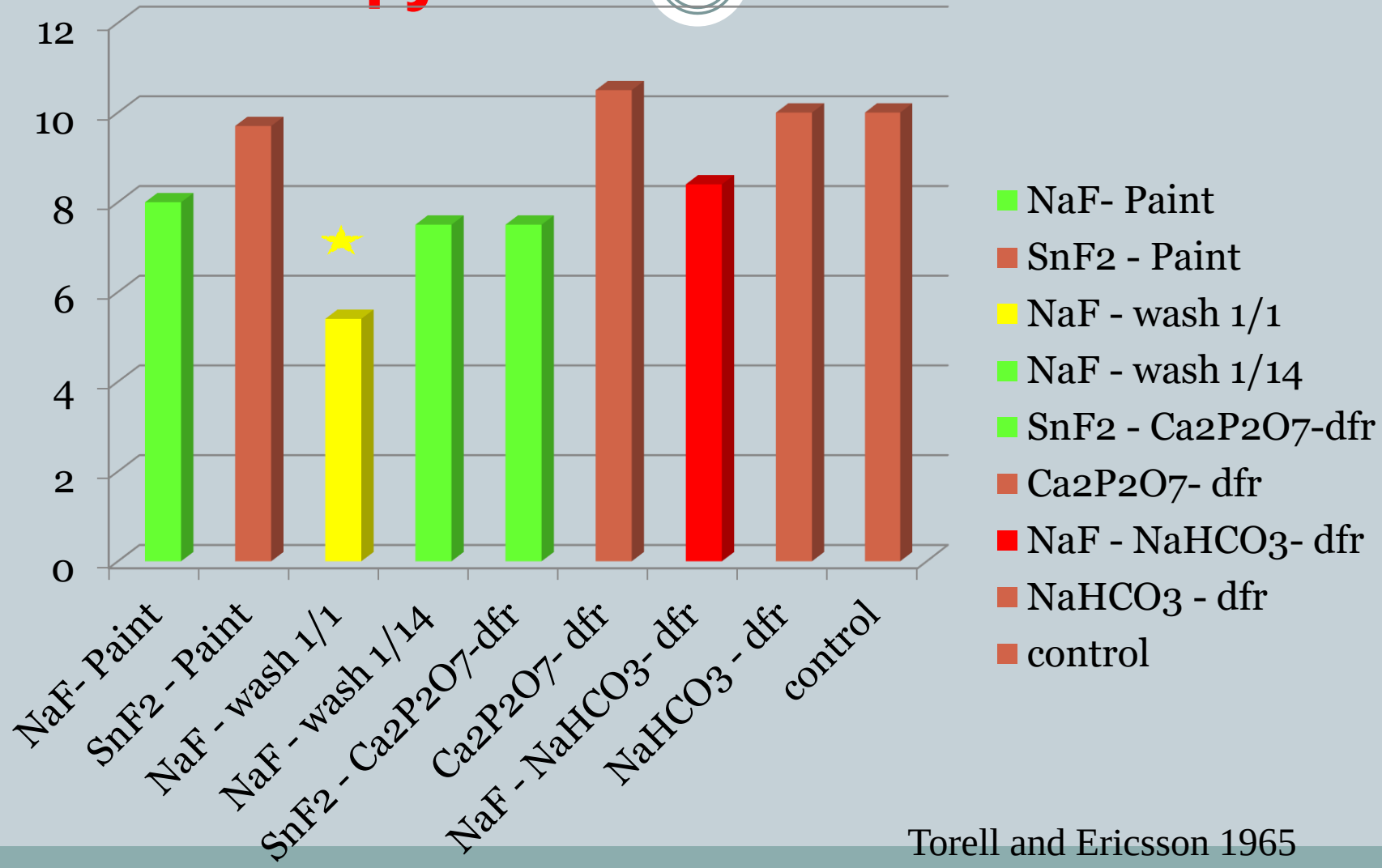
Inclusion criteria – randomised or controlled clinical trial, atleast 2 year follow up

Out of 174 articles 62 met the inclusion criteria

Studies independently assessed by two reviewers and scored A-C according to predetermined criteria for methodology and performance

Twetman S et al. Caries preventive effect of sodium fluoride mouthrinse: a systematic review of controlled clinical trials. Acta Odontol Scand 2004; 62:223-230

Comparison of effectiveness with other methods of fluoride therapy



Torell and Ericsson 1965

Fluoride Impregnated Dental Floss

- For deposition of F on interproximal tooth surface
- Gillings --- developed dental floss containing NaF and SnF2
- Chaet & Wei: Found approx 3 times more fluoride in surfaces treated with fluoride impregnated dental floss than in those treated with plain floss

Fluoride Chewing Gum

- Mean F conc in whole saliva following the ingestion of chewing gum is markedly increased
- Peak F conc for a 0.25 mg preparation --- 15 – 25 ppm and 0.5 mg --- 25 – 40 ppm
- Most F release occurs during first 5 min
- At 30 min after ingestion, conc of saliva is 1 ppm
- Not recommended in preschool children

FLUORIDE GELS

Self applied gels for home use

NaF, APF – 5000ppm; SnF2 – 1000ppm

1 or more times a day

Trays kept in contact with teeth for 5 minutes

Expectorate excess and not swallow, rinse with tap water

Not recommended < 6 years

LIMITED VALUE:

Low conc at regular interval

Toxicity hazard

Tedious

ADA Guidelines

Patients with rampant decay

Quartely visit to dentist for topical fluoride

Four week course of self applied fluoride gel

The review of trials found that fluoride toothpastes, mouthrinses, and gels reduce tooth decay in children and adolescents to a similar extent.

However, toothpastes are more likely to be regularly used.

There is no strong evidence that varnishes are more effective than other types of topical fluoride

Marhinho VCC, Higgins JPT, Logan S, Sheiham A. One topical fluoride (toothpaste, or mouthrinse, or gels, or varnishes) versus another for preventing dental caries in child and adolescents. Cochrane Database of Systematic Reviews 2004, Issue 1

- Eleven out of twelve studies contributed data for metaanalysis
- For the nine trials that provided data for the main meta analysis on the effect of fluoride mouth rinses, gels or varnishes used in combination with toothpaste (involving 4026 children) the DMFS pooled PF was 10% in favor of combined regimen
- The only statistically significant result was in favor of the combined use of fluoride gel and mouth rinse in comparison to gel alone. (DMFS PF 23%)

Marhinho VCC, Higgins JPT, Logan S, Sheiham A. Combination of topical fluoride (toothpaste, or mouthrinse, or gels, or varnishes) versus single topical fluoride for preventing dental caries in child and adolescents. Cochrane Database of Systematic Reviews 2004, Issue 1

Self applied Fluoride Gels

- Self-applied fluoride gels were originally developed for application via custom mouth trays, though no single application regimen has been considered standard. Fluoride gels are currently available by prescription for self-application as APF and neutral NaF products containing 1.1% NaF (5,000 ppm F ion).
- Most often, an APF gel (1.1% NaF, pH 4.5 or 1.23% NaF, pH 3.2) has been employed
- Some manufacturers have reformulated their NaF gels with abrasives as a reflection of the increasing use of these products in a brush-on regimen. Glycerin-based SnF2 products (not true gels) are available with a concentration of 1,000 ppm F.
- Not recommended for children 6 years & younger

Self applied Fluoride Gels

- Advantages:
  -Self applied
  -Can be used many times as compared to office delivery
- Disadvantages:

-Cannot guarantee whether correctly used or not
-Danger of toxicity as large quantity is given
-Are tedious to use on a daily basis over a long period of time

- For a case of rampant case:

ADA recommends Quarterly visits to dentist for topical fluoride treatment and a minimum of 4 week course of self applied gel use

Table 2. Summary of the Author's Recommendations for the Use of Fluoride Regimens in Contemporary Pediatric Dental Practice*

Fluoride regimen	Recommendations
Dietary supplements	• Assay patient's primary source of drinking water; consider other sources of fluoride intake • Consider delaying supplementation until after eruption of permanent first molars • Ensure that parents understand risks/benefits of supplementation • Instruct patient to chew/swish supplement prior to swallowing • Prescribe no more than 120 mg F • No benefit to prenatal administration
Dentifrices	• Use in children <2 ys old should be based on caries risk assessment • Tooth-brushing for young child should be done by adult; brushing by older child should be supervised by adult • Use pea-sized dab of dentifrice in children with immature swallowing reflexes; older children can use larger amounts • Brush with fluoride toothpaste twice daily
Mouthrinses	• Reserve for use in children with moderate/high caries risk • Reserve for use in children who have mastered swallowing reflex • Recommend alcohol-free preparations
Self-applied gels/pastes (5000 ppm F)	• Reserve for patients in fluoride-deficient communities who are at increased risk for caries • Application should be done by adult for young child, and supervised by adult for older child • Application period should be 4 minutes • Allow patient to expectorate freely after application; postpone eating/drinking for 30 minutes • Use with caution in children who have not mastered swallowing reflex • Monitor effectiveness; terminate regimen when feasible
Professionally applied gel/foam (12,300 ppm F)	• Application frequency based on caries risk assessment • Follow a pumice prophylaxis with fluoride application • Use minimum amount of gel/foam necessary to cover teeth • Seat patient upright, use suction to reduce swallowing of product • Apply for 4 minutes • Allow patient to expectorate freely after application; postpone eating/drinking for 30 minutes
Fluoride varnish (22,600 ppm F)	• Use after pumice prophylaxis as noted for gel/foam application • Use in alternative restorative technique to arrest lesions in young, precooperative patients • Have patient refrain from eating/drinking for 30 minutes after application • Have patient postpone brushing teeth until following morning

**Table assumes that the baseline recommendation for all patients is twice daily use of a fluoridated dentifrice coupled with once- or twice-yearly professional application of fluoride gel/foam/varnish. Use of all regimens except fluoride dentifrice should be based on a caries risk assessment.*

Studies

- Muhler et al

  Reversal rate of 2-3% occurred after topical application of water but the rate was 22-25% after application of Stannous fluoride

- Loesche et al

  A series of APF gel (1.2% F) applications reduced S mutans, the most cariogenic organism but did not affect S sanguis

PUBLIC HEALTH PROGRAMS

Topical fluoride as home care measure in India

Fluoride dentifrice – for people who could afford it

Daily fluoride mouthrinse in form of 0.044%NaF mouthrise

Tewari A. Alternative Oral Health Care Delivery System, JISPPD Jan 2003

Topical fluoride in School preventive program

Fortnightly fluoride mouthrinse by 0.2% NaF solution

Preparation – dissolving 2 gms of NaF powder in 1 litre of

cold water

Topical application of 2% NaF solution once every six month

Preparation - dissolving 2 gms of NaF powder in 100cc of clean & cold water in a plastic jug

Tewari A. Alternative Oral Health Care Delivery System, JISPPD Jan 2003

Change in strategy of supplying fluoride tablets by ICMR

Original protocol – free fluoride tablets

Task Force Meeting of ICMR(10th July 1986)

Self purchase from village shops – pilot study

Department of Pharmaceutical Sciences, Punjab University – self dissolving NaF tablets – 10mg

Tested – self dissolving property& free F- ions available

Experimental area – 2 villages of Raipur Rani

Results – NaF tablets > acceptable NaF powder

NaF tablets safer – possibility of confusing NaF powder
with community used Kitchen salts

Procurement of Fluoride Tablet
KIM laboratories(Ambala, Haryana)- responsibility of making 10 gms NaF tablet (Fluoriwash)
Packets of 30 tablets – rate of Rs 1.5/packet

Implementation

Community

10mg of self dissolving NaF tablets especially manufactured for preparation of daily fluoride mouth rinse by the community at home

Preparation – 1 tab in 25cc(five tea spoons) of fresh cold water taken in a plastic cup and stirred with a plastic spoon.

Prepared solution – concentration of 0.04% of NaF

One tablet/ day – sufficient by a family(2 adults, 2 children)

Tewari A. Alternative Oral Health Care Delivery System, JISPPD Jan 2003

Implementation

School children

2 gms of NaF in plastic jug with 1000ml of cold, clean water(0.2% fortnightly mouthrinse)

5-8cc for each child, Swish around for 2 minutes and spit

Not to eat/drink anything for 2 hours after rinse

Teachers trained – 2 gms in 100cc of water in plastic jug, stirred with plastic spoon(six monthly application 2% NaF)

5 ml to each child for 30sec- 1 minute, keep mouth open for letting teeth dry for 4-5 minutes

Tewari A. Alternative Oral Health Care Delivery System, JISPPD Jan 2003

RECOMMENDATION PROCEDURE- AVOIDANCE OF MISHAPS

- Clear delineation of responsibility b/w family practitioner and health authority staff – public/ school health programs
- No F supplement prescribed until complete picture of F uptake from all sources has been obtained
- Definite indication for use of any supplement
- F ingested from all sources on a continuous long term basis during amelogenesis should be below that likely to cause fluorosis
- High conc solutions of F supplement – never prescribed

RECOMMENDATION PROCEDURE- AVOIDANCE OF MISHAPS

- Concentrated F mouthrinses for young children – not recommended
- Use of measured quantity of effective preparation doesn't mean that more of it is better
- Dentist should monitor work of office personnel in responsible manner
- Supervisory dental personnel - thorough knowledge of fluoride containing preparations
- Preparations for home –less than acute toxic dose for young children

CONCLUSION

A number of different aspects of topical fluoride have been reviewed in the foregoing material.

Without doubt its use contributes to significant reduction of dental caries; however one cannot expect to control caries completely through use of topical fluorides alone.

Furthermore no single F treatment provides the maximal degree of caries protection possible with fluoride, use of multiple fluoride therapy is advocated.

The dentist should identify the need of patients / community and accordingly chose the regimen to be implemented.

CONCLUSION

- ✓ Fluoride makes the entire tooth structure more resistant to decay.
- ✓ It combines into the tooth structure to make enamel more resistant to acid attack.
- ✓ It is toxic to bacteria, it stops the bacteria from producing acids that cause tooth decay.
- ✓ Its use can encourage remineralization or replace minerals in the tooth surfaces that have been demineralised.

- It aids in the development of enamel on baby teeth before they erupt.
- In spite of its so many advantages, toxicity still remains the risk factor.
- But if used judiciously, fluoride is the nature's answer to tooth decay.
- It can be said that fluoride is a "double-edged sword" and therefore, its optimal & cautious use is recommended for beneficial effects.

References

- Mellberg JR. Fluorides in Preventive Dentistry. 1st ed. Quintesscence Publishing Co. 1982
- Text Book of Pedodontics by Shobha Tandon
- Fejerskov o, Ekstrand J. Fluorides in dentistry, second edition
- Peter S. Essentials of Preventive and community dentistry 2nd edition, Arya publishing house, New Delhi. Fluorides.
- Peterson LG et al. Professional fluoride varnish treatment for caries control: a systematic review of clinical trials. Acta Odontol Scand 2004; 62: 170-76

References

- Hiremath SS. Textbook of Preventive & Community Dentistry. 1st ed. Elsevier publishers 2007.
- Murray JJ. Fluorides in caries prevention. 1st ed. Varghese publishing house 1991
- Adair SM. Evidence-based Use of Fluoride in Contemporary Pediatric Dental Practice; Pediatric Dentistry – 28:2 2006; 133-142
- Harris N.Primary preventive dentistry . 2nd edition: Pearson education inc, NJ
- Pessan JP; Slow-release fluoride devices:A literature review; *J Minim Interv Dent 2009; 2 (4); 223-236*

References

- Fluorides & Oral Health: Report of a WHO Expert Committee on Oral Health Status & Fluoride Use: Geneva 1994
- Nikiforuk G; Understanding Dental Caries: Prevention: Basic & Clinical Aspects; Karger; New York, 1975
- Tewari A. Alternative Oral Health Care Delivery System, JISPPD Jan 2003
- Marhinho VCC, Higgins JPT, Logan S, Sheiham A. Combination of topical fluoride (toothpaste, or mouthrinse, or gels, or varnishes) versus single topical fluoride for preventing dental caries in child and adolescents. Cochrane Database of Systematic Reviews 2004, Issue 1

- Twetman S et al. Caries preventive effect of sodium fluoride mouthrinse: a systematic review of controlled clinical trials. Acta Odontol Scand 2004; 62:223-230
- Bonner BC, Clarkson JE, Dobbyn L, Khanna S. Slow-release fluoride devices for the control of dental decay. *Cochrane Database of Systematic Reviews 2006, Issue 4. Art. No.: CD005101. DOI: 10.1002/14651858.CD005101.pub2.*


THANK YOU
digitalblasphemy.com