

The use of fluoride in infants and children



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The introduction of fluoride to drinking water in 1958 resulted in a dramatic reduction of dental caries (1). Subsequently, fluoride supplements were advocated for children whose water was not fluoridated, and now almost all toothpaste contains fluoride. The result is that multiple sources of fluoride, such as fluoridated toothpastes, fluoride supplements (drops and lozenges) and naturally occurring fluoride, have contributed to an increase in the incidence of fluorosis. The challenge is to provide the right amount of fluoride in a reliable and safe manner. Fluoride has been found to be effective in preventing caries but there have been no controlled studies to evaluate the optimal dose.

The recommendations on fluoride use in a 1995 statement by the Canadian Paediatric Society (CPS) (2) differed substantially from those of the Canadian Dental Association (CDA). The position of the CDA (3) was that, apart from fluoride in water, the main source of fluoride should be fluoridated toothpaste, and that supplements should not be used in children younger than three years of age. The CPS position was that proper tooth brushing, especially in high risk populations, may be difficult to implement; that delaying supplementation until three years of age would result in higher caries rates; and that supplements should be started at six months of age (2). More recent studies of the actions of fluoride resulted in the modification of these two positions. The position outlined in the present statement follows the principles agreed on at the 1997 Canadian Consensus Conference on fluoride use (4).

FLUOROSIS

Dental fluorosis, a condition associated with abnormal enamel development, was first noted in communities with high levels of naturally occurring fluoride in the drinking water, but has since appeared in individuals ingesting fluoride from other sources.

This condition, occurring mainly in children younger than seven years of age, is associated with impaired biosynthesis of dental matrix. Manifestations can vary from minimal changes (Toxic Effect [TF] of 1), comprising 80% to 90% of the cases, and noted only by close dental examina-

tion; to rarer, florid, unsightly mottling and pitting of the teeth, enamel striations, and in severe cases, 'snow-capped cusps' and chalky-white teeth (TF of 2 or more), which may be unsightly and require cosmetic treatment. Secondary teeth are at the greatest risk for fluorosis at 15 to 24 months of age (5).

The prevalence of fluorosis has increased since 1945 (6), paralleling the increase in possible sources of fluoride, including water, toothpaste, foods and drinks made with fluoridated water, and fluoride supplements such as drops, mouthwashes and lozenges. Fluorosis prevalence varies inversely with caries control. In a large study of 18,755 children by Heller et al (7), the sharpest decline in decayed, missing, filled surfaces occurred with increasing drinking water concentrations of fluoride from 0 to 0.7 ppm, with little additional benefit above this concentration. The prevalence of fluorosis increased with increasing water fluoride concentration, from 13.5% in children exposed to water containing less than 0.3 ppm of fluoride to 41.4% when they were exposed to greater than 1.2 ppm. The use of supplements added to the effect and was associated with a further lowering of caries at the cost of increased fluorosis. A suitable trade-off between caries and fluorosis occurred at around 0.7 ppm of fluoride (7). Other studies (8-10) have also found fluorosis prevalence of greater than 40% with increasing fluoride exposure, although only a small proportion of dental changes due to fluorosis are noticeable enough for treatment to be considered. A recent study of fluorosis among 2435 children aged seven to 13 years in Toronto, Ontario (11) found dental fluorosis of moderate degree (Tooth Surface Index of 2 – fluorosis of moderate severity) in 14% of seven-year-olds, 12.3% of 13-year-olds and 13.2% of the two groups combined, a prevalence similar to most of the recent studies performed in Toronto.

MECHANISM OF ACTION OF FLUORIDE

Fluoride prevents caries mainly by its topical effect (12). Dental caries result when plaque, a sticky film of bacteria on the surface of the tooth, feeds on sugar and food residue to produce acid, which dissolves the surface of the tooth

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TABLE 1
Levels of evidence of the mechanisms of action of fluoride in preventing tooth decay

Level of evidence (18)	Description
I	Evidence obtained from at least one properly randomized trial
II-1	Evidence obtained from a well-designed controlled trial without randomization
II-2	Evidence obtained from well-designed cohort or case controlled analytic studies, preferably from more than one centre of research
II-3	Evidence obtained from comparisons between times and places, with or without the intervention. Dramatic results in uncontrolled experiments could also be included in this category
III	Opinions of respected authorities, based on clinical experience, descriptive studies or reports of expert committees
Recommendations for preventive measures	
A	There is good evidence to support this recommendation
B	There is fair evidence to support this recommendation
C	There is poor evidence to support this recommendation, but a recommendation could be made on other grounds
D	There is fair evidence to support the recommendation of exclusion
E	There is good evidence to support the recommendation of exclusion

(demineralization). Bathing the surface of the tooth with as little as 1 ppm of fluoride causes a dramatic decrease in enamel solubility. Ingested fluoride, on the other hand, has little effect on caries, but contributes significantly to the development of fluorosis.

Enamel development is characterized by three stages.

- In the secretory stage, a protein matrix is laid down and mineral deposition begins.
- In the transition stage, protein is removed and replaced.
- In the maturation stage, protein is 95% replaced and mineralization is complete.

Fluoride delivered systemically to the tooth affects both the transition and maturation stages. Enamel development is most sensitive to systemic fluoride during the transition stage. The matrix becomes porous as fluoride and other ions accumulate. In the maturation stage, altered mineral depo-

sition occurs. This effect of fluoride results in interference with crystal deposition, altered cell modulation and delayed maturation of bone.

Topical fluoride acts in three main ways to prevent dental caries (12).

- It inhibits plaque. Fluoride may kill or inhibit bacteria and makes them less able to produce acid from carbohydrates.
- It inhibits demineralization. Fluoride is incorporated into crystals on the tooth surface, making the surface more resistant to acid.
- It enhances remineralization of enamel. The process of demineralization and remineralization of enamel is constant. Fluoride increases the speed of this process and the incorporation of fluoride in the mineral makes it less soluble to acid.

TOOTHPASTE

Toothpaste is available with or without fluoride. Toothpaste tubes containing fluoride are now labeled and contain approximately 0.5 mg fluoride per gram of toothpaste. Some tubes suggest covering the bristles with toothpaste. A 'pea-sized' portion weighs approximately 0.75 g and contains about 0.4 mg of fluoride; a 'full cover' portion weighs approximately 2.25 g and contains about 1.0 mg of fluoride. Thus, brushing twice a day would deliver 0.8 to 2.0 mg of fluoride, depending on which regimen is used. If swallowed, the amount of fluoride could be excessive and could contribute to the development of fluorosis.

UNDERLYING CONSIDERATIONS

- The primary mechanism of the action of fluoride in preventing tooth decay is topical (evidence level II-3, recommendation B) (11,13,14) (Table 1).
- Water fluoridation is an effective delivery method for topical fluoride (evidence level II-1, recommendation B) (1).
- Fluoridated toothpaste is an effective delivery method for topical fluoride (evidence level I, recommendation A) (15).
- The ingestion of more than the recommended daily dose of fluoride is associated with an increased risk of dental fluorosis (evidence level II-2, recommendation E) (2,16).
- In the absence of adequate topical fluoride exposure (eg, fluoridated toothpaste or water), additional fluoride products may be provided in the form of drops, chewable tablets and lozenges. The effectiveness of these products in preventing dental caries is low in school-aged children (evidence level II-2, recommendation C) and has not been evaluated in infants and toddlers (evidence level II-3, recommendation C) (8).

- Some individuals may be susceptible to 'cariou challenge'. Because of either a genetic or an environmental predisposition to a high prevalence of caries (17-21), topical fluorides alone may be insufficient to prevent caries among these individuals (ie, additional fluoride may produce no net benefit and other measures such as antibacterial therapy and diet changes may be required) (evidence level II-3, recommendation C) (22).

RECOMMENDATIONS

There is no doubt that the use of fluoride decreases dental caries. On the other hand, it is clear that the ingestion of too much fluoride can result in varying degrees of fluorosis. Thus, in practice, the administration of fluoride should strike a balance between the two situations.

- The position outlined in the present statement follows the principles agreed to at the Canadian Consensus Conference on fluoride held in 1997 (4).
- Fluoride should continue to be added to municipal water supplies where natural concentrations are less than 0.3 ppm.
- A statement of fluoride concentration should continue to be printed on the toothpaste tube, and the amount in a 'pea-sized' portion of toothpaste should be indicated.
- Fluoride concentrations should be stated on any foods or drinks containing fluoride.
- Children should use only a 'pea-sized' amount of toothpaste, and be encouraged not to swallow the excess.

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TABLE 2
Recommended supplemental fluoride concentrations for children

Age of child	Fluoride concentration	
	<0.3 ppm	>0.3 ppm
0 to 6 months	None	None
>6 months to 3 years	0.25 mg/day	None
>3 to 6 years	0.5 mg/day	None
>6 years	1.00 mg/day	None

- Because the action of fluoride is topical, no fluoride should be given before teeth have erupted.
- Supplemental fluoride should be administered (Table 2) only from the age of six months, and only if the following conditions prevail:
 - the concentration of fluoride in drinking water is less than 0.3 ppm;
 - the child does not brush his or her teeth (or have them brushed by a parent or guardian) at least twice a day; and
 - if, in the judgment of a dentist or other health professional, the child is susceptible to high caries activity (family history, caries trends and patterns in communities or geographic areas).
- Supplemental fluoride should be given in preparations that maximize the topical effect, such as mouthwashes or lozenges. Drops, if used, should be diluted with water and squirted on the teeth.

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The recommendations in this statement do not indicate an exclusive course of treatment or procedure to be followed. Variations, taking into account individual circumstances, may be appropriate.

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