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Short Communication

Unlocking the Power of Fluoride: Benefits and Risks for Teeth

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Abstract

Fluoride, a naturally occurring element, has been a cornerstone in dental health for decades. Its ability to strengthen tooth enamel and prevent cavities is well-established. However, the use of fluoride is not without controversy, as concerns about overexposure and potential risks have arisen. This present paper explores the complex relationship between fluoride and dental health. It examines the mechanisms by which fluoride interacts with teeth during their formation and maturation, as well as its role in preventing dental caries after eruption. The benefits of fluoride supplementation, including water fluoridation, toothpaste, mouthwash, and dietary sources, are discussed. By understanding the science behind fluoride and its impact on oral health, individuals can make informed decisions about their dental care.

Keywords: *Fluoride; Oral Health; Dental Care*

Introduction

The fluorine is a chemical element. In its elemental form, fluorine is a highly yellow toxic and corrosive gas. It belongs to halogen family. The ionic form of the fluorine is fluoride [1].

Because of it's electronegativity, it never exits in a free state. That's why, it is combined with other elements, in nature, as fluoride compounds [2]. Fluoride is abundant in various minerals [1] fluorspar, cryolite, apatite, rock phosphate mica, and hornblende.

Fluoride has long been recognized as a key element in maintaining dental health, renowned for its ability to strengthen tooth enamel and prevent cavities [1]. However, the use of fluoride is not without controversy, as concerns about potential overexposure and its associated risks have prompted ongoing debate. Striking the right balance in fluoride usage is crucial for optimizing dental care, ensuring that the benefits are maximized while minimizing any potential downsides. This article delves into the interaction between fluoride and teeth, exploring both its positive impacts and the challenges it presents in maintaining oral health.

Fluoride and tooth interaction

From the third month of in utero life to the age of 12 years, the fluoride interacts with dental organs both dentitions: temporary and permanent [1,3,4].

The effects of fluoride on various dental tissues can be observed from the formation phase and can be maintained for about two years after eruption.

During the phase of formation and pre-eruptive maturation

During the amylogenesis, Fluorine interact with the cellular metabolism of both ameloblasts and odontoblasts cells. At the stage of enamel mineralization, Fluorine interfere with the matrix by producing stable forms of hydroxyapatite, carbonate and magnesium. It is, gradually, integrated into the crystal lattice. It will fuse to the hydroxyapatite lattice of tooth enamel forming the fluorapatite reducing the solubility of the mineral. Thus, it allows more stability and greater resistance [4,5]. This effect of fluoride on ameloblast

and odontoblast cells is dosage dependent (between 0.03 and 0.1 mg fluoride/kg/day). it is possible observe metabolic disturbances of ameloblasts and odontoblasts. Exceeded fluoride would develop dental fluorosis.

After the teeth eruption

Once the tooth emerges in oral cavity, the enamel is exposed to the oral environment as saliva, food and bacterial plaque. For newly erupted teeth, this hard tissue is immature and porous. Consequently, it is prone to dental caries [4]. Indeed, during 2 years after the eruption, the tooth continues its maturation by altering stages of demineralization and re-precipitation. The abrasion of the enamel reliefs promotes the plaque anchoring while the progressive filling of surface porosities makes the enamel more resistant to caries. These formations are unstable over time and fluoride intake must be renewed to bring beneficial effects in terms of resistance to decay [4].

Fluoride supplementation

Several studies highlighted the causal relationship between the use of water containing fluoride and the prevention of dental caries [4-6].

In 1986, the World Health Organization (WHO) recommended that the ideal Fluoride concentration in water is about 1 ppm or 1 mg per liter to prevent the tooth decay without causing esthetic inconvenience [4,6]. Water fluoridation was adopted in many countries. In 1945, Grand Rapids City (Michigan) was the first to apply water fluoridation [7]. In 2016, about 73% of the United States served by community water systems had access to fluoridated water. Due to its contribution to the dramatic decline in tooth decay over the past 75 years, Center for Disease Control (CDC) named community water fluoridation as 1 of 10 great public health achievements of the 20th century. Comparing to other prevention methods, it seems to be the most effective method for the prevention and treatment of dental caries.

The supplementation of Fluoride could interest, also, the milk for young children or medicine (Example of tablets: Zymafluor®, Fluor Montal®, Fluor In®, Fluorex®) [8].

Due to the cariostatic effect ensuring the reduction of caries' risk, the topical fluoridated plays a major role in the interruption of the demineralization process and in the initiation of its remineralization after the teeth eruption. It concerns mainly the tooth paste toothpaste (< 1500 ppm). The highly concentrated varnish and mouthwash increase the resistance towards tooth decay. (example: Fluorine Protect® 7000 ppm, Duraphat® 22600 ppm). This topic supplementation is suitable for people with high risk of dental caries or with active dental caries. All these supplementation measures should inadvertently lead to excessive fluoride intake and potentially cause dental fluorosis.

Fluoride and human health

Excessive or deficient exposure to fluoride can have adverse effects on human health [9,10].

The majority of the fluoride is absorbed from the stomach and small intestine into the blood stream leading to an increase of fluoride levels in the blood. The peak concentration is observed within 20 - 60 minutes. Thus, it declines rapidly, within 3 - 6 hours, as it is up taken by hard tissue like bone, tooth. Approximately, 99% of the intake fluoride is associated with hard tissues [11].

Fluoride exists in both ionic and bound forms in plasma, with the bound form being present in larger quantity. Fluoride concentrations in human saliva are slightly less than those found in plasma, ranging from less than 0.01 to 0.05 ppm [10,11].

Tooth decay or enamel demineralization is caused by deficient exposure during tooth formation. Dental fluorosis is caused by an over fluoride exposure occurring during tooth mineralization. Skeletal fluorosis, as well [11]. Clinically, it can vary from barely discernable white marks to confluent pitting and discoloration of affected teeth [2,3]. It's severity depends on the concentration, duration, and time of exposure to fluoride.

In 1999, The UNICEF estimated that dental fluorosis affects 25 countries around the world, particularly in Africa, the Eastern Mediterranean and South Asia [1,8].

To prevent from dental decay, the fluoride concentration should be higher than 0.5 mg/L is recommended for [11]. A daily fluoride intake of 122 mg/L, can occur dental fluorosis [9]. Intakes fluoride exceeding 200 mg/L, may arise the skeletal fluorosis [9].

The Food and Nutrition Board (FNB) at the National Academies of Sciences, Engineering and Medicine [12] has established the upper daily tolerable Intake Levels for Fluoride (Table 1).

Age	Male	Female
Birth to 6 months	0.7 mg	0.7 mg
From 7 to 12 months	0.9 mg	0.9 mg
From 1 - 3 years	1.3 mg	1.3 mg
From 4 - 8 years	2.2 mg	2.2 mg
From 9 - 13 years	10 mg	10 mg
From 14 - 18 years	10 mg	10 mg
From 19 - 51 years	10 mg	10 mg

Table 1: *Daily tolerable upper intake levels for fluoride [12].*

Conclusion

Fluoride remains a powerful tool in the fight against tooth decay, offering significant benefits by strengthening enamel and reducing the risk of cavities. However, like any potent agent, its use requires careful consideration and balance. While the appropriate levels of fluoride can greatly enhance dental health, overexposure can lead to potential risks such as dental fluorosis and other health concerns. It is essential for dental professionals and individuals alike to be informed about both the advantages and possible downsides of fluoride use. By understanding and managing these risks, we can ensure that fluoride continues to be a valuable ally in promoting long-term oral health.

Conflict of Interest

The authors declare no conflicts of interest.

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