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Dental Fluorosis and Fluoride in Consumable Products

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Teeth are interesting little things. They have the ability to tell the story. In this case, how the person was affected by the environment that they lived in. In most places in the world, there is fluoride either in the ground or in the water. For the most part, fluoride is good for the teeth; it has the ability to strengthen them. Yet, in some places were levels of fluoride are high, the relationship between teeth and fluoride take a turn for the worse and result in dental fluorosis.

Dental fluorosis causes a change in the tooth's enamel crown that results in discoloration or disfiguration, based on the severity of the dental fluorosis. The discoloration or disfiguration ranges from white spots to brown streaks to pitting on the tooth's surface enamel. Fluorosis is caused by the over-consumption of fluoride during the developmental period when the teeth, both deciduous and permanent, are forming inside the gums. The severity of fluorosis is determined by two things: the amount of fluoride consumed and how long fluoride was being consumed. Until the teeth have erupted, they are at risk of developing some degree of fluorosis (Shannon 2012).

To help dental professionals identify cases and severity of fluorosis, there are various classification guides created to help. The classification system created by H. Trendley Dean distinguishes the different stages of dental fluorosis (Buzalaf 2011). While there are other classification systems that have been created, such as Thylstrup and Fejerskov's Fluorosis Index and the Total Surface Index of Fluorosis, the system that was created by Trendley Dean is still the preferred system in use today. Levels used in the H. Trendley Dean's Index are normal, questionable, very mild, mild, moderate, and severe. Normal is classified as the tooth's surface being smooth, glossy, and usually an off-white coloring. Questionable is classified as the tooth possibly having a few white flecks or spots. Typically this rank is only used when a tooth doesn't quite fit the "normal" or "very mild" classification levels. Very mild is classified when the tooth's surface is covered with white spots or flecks that cover over 25% of the total surface area. A mild classification is given when greater than 50% of the tooth's surface is covered with white spots or flecks. A moderate classification is when the tooth's entire surface is affected by white markings and attrition tooth wear is visible. It is common in this stage that brown stains appear on the tooth. Severe is classified when the tooth's entire surface is affected by white spots, pitting of the tooth's surface occurs, and there is widespread brown staining on the tooth's surface. It is also common to see hypoplasia, which is pitting or striations on the tooth's surface, at this stage of fluorosis. The tooth at this stage may have a corroded appearance to it. People who are at risk of developing dental fluorosis are children that are under the age of 8 years old when the crowns are still forming (Buzalaf 2011).

While dental fluorosis doesn't have serious health consequences unless it is severe, people tend to find ways to fix the appearance of their teeth for cosmetic reasons. There are

five different types of treatment options. The first treatment option is porcelain laminate veneers. The procedure consists of a dental professional shaving away about 1mm of the tooth's surface and then placing a veneer over the area that was shaved away (Oral Answers 2011). The second treatment option is enamel microabrasion. A dental professional would first treat the tooth's surface with an acid to demineralize the tooth's surface. They would then sand down part of the tooth's surface to get rid of the fluorosis markings. They would then apply a topical fluoride to the tooth's surface to help remineralization the tooth (Oral Answers 2011).

The third option is to do direct composite veneers. This procedure is very much like the procedure for the porcelain laminate veneers. Where the two procedures differ is after the tooth has been shaved down, the dental professional covers the shaved area with a white composite filling material. The one drawback to this procedure is that it will only last a few years before it will have to be replaced due to everyday wear and tear (Oral Answers 2011).

The fourth treatment option is to have a dental crown placed on the tooth. For this procedure, the dental professional will shave down the whole tooth and then place a crown on the tooth (Oral Answers 2011). The fifth treatment option is to get dental implants. This procedure is the least common among treatment options because it is costly and invasive. For this procedure, the dental professional would first have to remove the tooth that is affected with fluorosis. They would then set in a dental implant into the area that was previously occupied by the affected tooth (Oral Answers 2011).

As stated earlier, the overconsumption of fluoride is the cause of fluorosis. While most people know that fluoride is added to various kinds of dental care products, most people don't

know that fluoride naturally occurs in a lot of things that we eat or drink. With the risk of developing fluorosis in children under the age of 8 years old, it is important to understand how fluoride works in the body and why it is needed.

Fluoride is used to strengthen a person's teeth and to help prevent and/or reduce the severity of dental caries. Fluoride can be found, in some extent, almost anywhere around the world, in varying levels, because fluoride is the 13th most abundant element found in the ground (Buzalaf 2011). While it is found in most areas around the world, there are areas that have a higher concentration of fluoride. Areas of high fluoride concentrations in the United States are in Colorado, Oklahoma, New Mexico, and Idaho. Across the world, there is a belt of high fluoride concentration along the East African Rift and a belt that runs from Turkey through the Middle East to China and Japan (World Health Organization n.d.).

Fluoride can enter the body in several different ways. Food, in general, typically has a low concentration of fluoride in it. There are, however, some food items that are higher in fluoride concentration than average. These include fish, teas, fruits, and vegetables (Myers 1978). The most common source of fluoride is water. Most water has some amount of fluoride in it, whether it is a small, optimal, or large amount. In the United States and a few other countries around the world, it is common to regulate the amount of fluoride in a water source through fluoridation, which either adds or removes fluoride to maintain optimal fluoride levels of 1 part per million in community water sources (American Academy of Pediatrics 2016). Even the bottled water that we drink may have fluoride in it. While the amount of fluoride that is in bottled water is regulated by the FDA, the amount of fluoride allowed varies. For bottled water

that adds fluoride, the allowed ranges is from 0.8 to 1.7 m/l. For bottled water that doesn't add fluoride, the amount allowed ranges from 1.4 to 2.4 m/l. (FDA 2015)

A lesser amount of fluoride exists in the air. The fluoride that is in the air is generally in the form of dust, gaseous fluoride, or hydrogen fluoride. The fluoride that is in the air makes up for a minuscule portion of the fluoride that is absorbed in the body (Myers 1978). Fluoride also enters the body through the use of dental care products. These products include, but are not limited to, toothpaste, mouthwash, and fluoride tablets (Buzalaf 2011).

Once in the body, fluoride can get to the teeth by two different types of absorption: topical or systemic. Topical absorption is done by using dental care products. Dental care products apply the fluoride directly to the teeth. The fluoride that is applied to the teeth help with remineralization process that strengthen teeth after acidic foods/drinks, plaque, and other bacteria in the mouth demineralize the tooth surface, weakening it to make it more susceptible to dental caries. Any product that is topically applied can't cause fluorosis due to the teeth having already erupted (Centers for Disease Control and Prevention 2015). Yet, if any dental care products containing fluoride are repeatedly swallowed and there are unerupted teeth, a person may be at risk of developing fluorosis due to systematic absorption (Oral Answers 2011).

The systematic absorption of fluoride occurs after food, drinks, or dental care products have been ingested. The systematic way of absorption is a two part process. The first stage is that fluoride is absorbed by the stomach and small intestines after ingestion. It takes roughly 30 minutes for this process to be completed. The second stage determines where the absorbed

fluoride goes. About 50% of the absorbed fluoride will go into hard tissue, which is bone and teeth, and the other 50% will be excreted out of the body. (Buzalaf 2011).

While fluoride is found in many different sources, there are only a few sources that have enough fluoride in them that could put a person at risk for dental fluorosis.

One of the major sources that could put a child at risk for fluorosis is fluoride supplements. Fluoride supplements are usually only prescribed to a child if they live in an area where there is a low fluoride concentration in the water and/or the child is at a high-risk level for developing or having severe caries (Shannon 2012). There are sources that suggest that by using fluoride supplements, you may be able to reduce the likelihood of caries, but the use of supplements also increase the risk of developing fluorosis because supplements are systematically absorbed (Buzalaf 2011).

Another one of the major sources of fluoride in the diet is from toothpaste, mouthwashes, or other similar products containing fluoride. While the main use of fluoridated toothpaste or mouthwash is for topical application, children accidental swallow these products while using them. While there is a small risk from swallowing these products from time to time, the higher the frequency and the amount of product swallowed could increase the likelihood and severity of fluorosis (Buzalaf 2011). To help reduce the occurrence of fluorosis, suggestions have been made as to when and how much fluoridated products should be used. For toothpaste, it is recommended that children under the age of two years old should not use fluoridated toothpaste, unless directed otherwise. For children ages 2 to 6 years old, it's recommended to use no more than a pea-size amount of fluoridated toothpaste. For

mouthwashes, it is recommended that children don't use them under the age of 6 years old, unless directed otherwise (Shannon 2012).

One of the other major sources for fluoride is infant formula. Fluoride is introduced to the infant formula by either mixing when mixing infant formula mixes with water that contains fluoride or in ready-to-go formulas where the water has already been added (Buzalaf 2011). It's suggested to help reduce the risk of fluorosis that the infant should also be breastfeed, if possible, and in areas of high fluoride concentration, to use bottled water that has low fluoride content. (Shannon 2012).

The last major source of fluoride is fluoridated water. Fluoridated water is the source that is closely linked to fluorosis because it is widely available with about 75% of the United States having access to fluoridated water (Centers for Disease Control and Prevention 2015). By adding the fluoride to water, people of all backgrounds were able to reap the benefits of this program due to water being the main liquid being consumed. While fluoridation is seen as one of the "greatest public health achievements in the world of last century" (Buzalaf 2011), there was a downside. The downside was the increased occurrence of fluorosis in areas with fluoridation. While the number and severity of caries have decreased since the introduction of fluoride in water, in a review done in 2000 that looked at over 200 studies focused on dental fluorosis, it was found that fluorosis was found in about 40% of the children studied. So, in 2011, the United States Department of Health and Human Services lowered the recommended fluoridation levels that ranged from 0.7-1.2ppm, set in 1962 by the United States Public Health Service Drinking Water Standards, to 0.7ppm. Fluoride is kept in public water sources despite

the risk of dental fluorosis because of the benefit to help reduce the occurrence and severity of caries (Buzalaf 2011). The recommendation in trying to prevent fluorosis is to know the fluoridation level in the community and to be aware of the other sources of fluoride in a person's diet, including food and beverages (Myers 1978).

Fluoridation of water first began in 1945 in Grand Rapids, Michigan when they adjusted the level of fluoride in the water to 1ppm (National Cancer Institute 2012). What most people don't realize is that fluoridation projects not only add fluoride to water that needs it, but that it also removes any excess fluoride that is in the water bringing it down to the recommended fluoride level. The types of fluoride that are added to water sources are fluorosilicic acid, sodium fluorosilicate, and sodium fluoride (American Cancer Society 2015). As of 2012, fluoride has been regulated in the majority of water sources across the United States (Centers for Disease Control and Prevention 2015).

Since the introduction of fluoride into public water systems, there has been opposition to it in some form or another. When fluoridation first began, one of the main opposing groups was the John Birch Society. One of the more prominent opposition groups/sites today is Fluoride Action Network (Connett 2012). These opposing groups and many others promote various conspiracy theories supporting their claims that fluoride is bad ranging from ideas that it was a Nazi/Communist plot to fluoride is a poison to various other health concerns.

At the time of the introduction of fluoride into water sources, the biggest opposing theory was that fluoridation was a Nazi or Communist plot. The idea behind this was that supposedly the Germans and the Russians had used fluoridated water in prisoner war camps in

WWII as a way to dull the mind to make the prisoners more obedient (Information Liberation 2006). While there was more than one person (Charles E. Perkins, George Racey Jordan, Kenneth Goff, and Emanuel Bronner) making this claim, when asked to provide proof of their claims, none of them did (Skeptical Vegan 2013). Since there was nothing substantial to support this claim, it has mostly faded away.

Another theory from groups that oppose fluoridation is that fluoride is a poison that can possibly kill a person (Information Liberation 2006). While this is true, opposition groups tend to over exaggerate the potential that fluoride could actually harm or kill you. There are two types of fluoride poisoning: acute and chronic (Buzalaf 2011).

Acute poisoning is the ingestion of a large quantity of fluoride within a short amount of time. Acute poisoning from fluoride was more likely to occur in the first half of the 20th century. This was because sodium fluoride was being used as an ingredient in pesticides and rat poisons that resembled the look of flour, baking soda, and many other cooking ingredients. In 1942 at the Oregon State Hospital, a cook mixed 10 gallons of eggs with 17 gallons of sodium fluoride, thinking it was powered milk. This mix-up resulted in 263 cases of acute poisoning that lead to 47 deaths. Today, there is a low chance of a person suffering from acute poisoning. The people that are at risk are mainly children. Yet, the chance of fatal acute poisoning is low because a child would have to consume about 7.6oz of fluoridated mouthwash or 1.76oz of fluoridated toothpaste or, for a child that weighs less than 10kg, 100 fluoride supplement tablets at the strengthen of 0.50mg or 5 liters of fluoridated water for every kilogram the consumer weights (Buzalaf 2011).

Chronic poisoning is the ingestion of fluoride over a long period at levels that are higher than the recommended levels. The result of chronic poisoning is dental or skeletal fluorosis. As mentioned earlier, dental fluorosis is a cosmetic issue, except in a severe case. Skeletal fluorosis has the potential to make bones become brittle and have a higher risk of fracturing (Connett 2012). While opposing groups think that fluoride is poisonous to a person's health, they ignore the fact that in the recommended levels, fluoride is beneficial to the body. (Buzalaf 2011).

Recently, opposition groups started claiming that there is a link between fluoride and cancer. This is due to a study performed in 1990 on rats that showed an increase in a number of osteosarcomas present after the rats were given water with high amounts of fluoride. Since then, the National Institute of Cancer states that other studies, performed on both humans and animals, have not produced any results that would support the claim that fluoride could cause cancer (National Cancer Institute 2012).

Despite all the different theories that anti-fluoridation groups give for saying that fluoride is dangerous and has no place being in our water, it's all just bark and no bite. Fluoride was added to the water as a way to help protect the teeth of everyone in a community despite any differences in race, creed, or income. While there is some risk to be had with fluoridating a community water source, the benefits that come with it are well worth the risk. To help reduce the prevalence of dental fluorosis, there need to be more regulations put into place on various consumable items that may content fluoride and more awareness of the amounts of fluoride in various products, along with teaching the risks and benefits of fluoridation.

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