Research Inventy: International Journal of Engineering And Science
Vol.10, Issue 7 (July 2020), PP 11-16
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com

Sealing cap for the toothpaste enclosure with the amount of archetype expelled for children in the formation of the dental germ

[1]Guilherme Augusto Alles, [2]Gabriel Soares Ledur Alves, [3]Alexandre Giacomin, [4]José de Souza

[1, 2, 3 & 4]*Fundação Liberato - Diretoria de Pesquisa e Produção Industrial (DPPI) - Rua Inconfidentes, 395, Bairro Primavera, Novo Hamburgo - RS - ZIP CODE 93340-140, Brazil.*
Corresponding Author: José de Souza – josesouza@liberto.com.br

Abstract: *This paper's objective is to develop a cap for the quantity of toothpaste for expelling the index of 0.07 milligrams of fluoride ions for each milligram of its body mass per day for children under seven years. The rationale is that children younger than seven years should not regularly ingest excess fluoride because, above the indicated index, they are at serious risk of developing dental fluorosis. Being a pathology in which it arises only in childhood, more specifically in the formation of the dental germ, causing a problem for the rest of the life if not treated-causing small white patches (in the lightest cases) or brownish spots (in the most severe cases). This pathology does not cause any changes in oral health but generates a shift in color, which can cause aesthetic damage. The treatment is costly, and the most common are microabrasion and whitening. From this, we intend to develop a prototype, with polypropylene, that does not have large weights and dimensions, thus offering secure handling, transportation, and use. Also, we will study the optimal issues of brushing amounts between the child's weight and the parts per million fluorides of toothpaste.*

Keywords: *Dental fluorosis, Fluorine, Toothpaste, Children.*

Date of Submission: 18-06-2020 Date of Acceptance: 06-07-2020

I. INTRODUCTION

Many people brush their teeth daily to keep their oral health up to date, thus maintaining a healthy mouth, free of bacteria and germs that cause bad breath and oral diseases. For hygiene, a combination of toothbrush and toothpaste is necessary, in addition to time and the form of brushing [1]. The use of toothpaste with or without fluoride in the process of cleaning teeth in children's method is a very vast and complex subject.

Depending on the individual's life, the amount of toothpaste increases from the birth of the teeth to the full formation of the permanent dentition [2]. The ingestion of toothpaste during the creation of the tooth germ causes the formation of dental fluorosis, which is a disturbance in tooth formation that is manifested mainly by the change in the color of the enamel [3].

This pathology is characterized by excess fluoride in the body at the time of tooth formation [4]. The intensity of the manifestation of fluorosis varies according to the amount of fluoride to which the individual was exposed at the time of the formation of the tooth germ. It has the consequence of altering the tooth enamel. In the infantile phase, the control of the swallowing reflex insufficient. For this reason, they end up involuntarily expectorating the excess in the oral cavity. In this way, they end up ingesting the fluoride toothpaste and, consequently, can contract dental fluorosis in the future [5].

The data on the prevalence and incidence of dental fluorosis worldwide, and in Brazil is quite heterogeneous and varies according to the population analyzed [6]. In a study evaluating dental fluorosis in Canadian children in British Columbia, the prevalence was 60.0 %. In the USA, 26.0 % of children had dental fluorosis. A survey conducted in China found a variation of 6.2 % to 96.6 % in the prevalence of dental fluorosis in children, depending on the location studied. In Brazil, a study conducted with children living in Brasília (Brazil) found a prevalence of dental fluorosis of 14.6%. Another survey conducted in the city of Rio de Janeiro (Brazil) reported a prevalence of 7.9% of children with dental fluorosis [7].

The occurrence of dental fluorosis compromises the aesthetic appearance, implying embarrassment, difficulty in smiling. The physical appearance of the body, and especially the harmony of the face, has an important social and psychological function in human life and personal relationships [8].

Because of the goal of making the sealing cap for the toothpaste wrapper that works when the child presses the toothpaste prototype button for application on their brush with archetypal quantity to be expectorated, therefore, it will not contract pathology, and, based on theoretical references in pediatric dentistry.

II. LITERATURE REVIEW

The dentist recommends that patients brush their teeth three times a day. After breakfast, lunch, and, mainly, dinner. This recommendation needs to consider much more seriously for oral health care. In this case, more important than the number of times is the effectiveness of brushing [9].

Preventive daily care, such as proper brushing and the correct use of dental floss, helps to prevent dental problems from becoming more serious. We must keep in mind that prevention is the most economical, least painful, and least worrying way of taking care of oral health and that in doing prevention, we are avoiding the treatment of future problems. We can take some elementary steps to significantly decrease the risk of developing caries, gingivitis, and other oral issues [10].

Brushing your teeth well every day is not just important for maintaining a beautiful smile. The correct oral hygiene, accompanied by routine exams, helps to prevent infections and the worsening of diseases, such as pneumonia and diabetes. The latter, for example, causes dental problems and can lead to loss of bone and gingivitis [11]. Inflammations such as gingivitis, periodontitis, and bleeding are a gateway for bacteria that can fall into the bloodstream and cause or aggravate the disease.

Dental fluorosis derived from the exposure of the tooth germ, during its formation process, to high concentrations of the fluoride ion. As a consequence, there are enamel mineralization failures, with associated severity and related to the volume ingested [4].

Adequate exposure to fluorides helps to control tooth decay. A very high dose can cause brown pigmentation, with white spots and superficial hypomineralization, in homologous teeth, to the point where the enamel becomes very porous and highly stained [6]. Fluoride produces its pigmentation effect mainly during the formation and calcification of the paint, that is, between the fourth month of gestation and the age of eight. Many injuries affect permanent teeth, with a preference for molars and premolars. These lesions can extend to all teeth, including deciduous teeth, depending on the fluoride concentration, genetic predisposition, developmental stage, and duration of exposure [5].

Fluorosis can appear under several different aspects and has been classified as follows: Simple fluorosis: These teeth show brownish pigmentation, smooth enamel, and no surface defects. Opaque fluorosis: These teeth show grayish pigmentation or diffuse opacities. These changes are more commonly of superficial depth that can effectively be treated with microabrasion techniques. Fluorosis combined with porosity: Changes highly characteristic of the surface, which can take different forms [7].

In addition to the fluoride dosage, other factors interfere with the severity of the disease. Low body weight, skeletal growth rate, and bone remodeling periods are phases of more excellent fluoride absorption. Nutritional status, altitude, and changes in renal activity and calcium homeostasis are also relevant factors [4]. The disease is more frequent in teeth of late mineralization (permanent dentition) in children of low weight or precarious nutritional status or chronic renal failure. The age groups of early and second childhood considered to be the most at risk for ingesting systemic fluoride and, consequently, its harmful effects [12].

Projects developed using 3D modeling software, simulation, and computational support are suitable for Assistive Technology (AT) [13] or improvements in hospital devices and devices and to support people with disabilities [14-15].

III. MATERIALS AND METHODS

The research consists of a questionnaire in the dentistry office, applied to adults responsible for children between 1 and 6 years old. In this questionnaire, we sought the frequency of daily brushing, whether they use fluoride or not in toothpaste, with the answer being yes for fluoride in toothpaste. We ask whether children use adult or infant toothpaste. With the software Inventor Professional 2018, the prototype was sketched to have an understanding of what will be accomplished.

In addition to the questionnaire and several sketches in the software Inventor Professional Software 2018, research was carried out with several brands of children's toothpaste, to verify the value in grams and milliliters, to obtain the highest density and thus the best coefficient of safety for brushing children.

After obtaining the value of 0.22 g, which is ideal and recommended by dentists, the prototype against dental fluorosis began, which will start from the activation of the rod that takes the toothpaste to the brush of teeth, in the appropriate dosage for children from the first dentition phase to the phase of permanent or deciduous teeth, which ranges from six to eight years of age.

As fieldwork, visits occurred to a School of Early Childhood Education, to an institution that has a project to work with children and to a dental office.

At school, an interview was done with the parents who agreed to participate in the research, asking how many brushings they made available to their children per day, what type of toothpaste their children used, and whether they wanted attention as to whether it was a child or adult toothpaste. Most parents answered that their children performed at least three brushings daily and that they preferred children's toothpaste and that it contained fluoride in its composition.

At the institution where the research occurs with the heads of eight children aged between two and six years old, it was concluded that they provided around three daily brushings to their children and paid attention. Based on the interviews and research carried out, a virtual prototype was created, which aims to demonstrate that if the child does the brushing with the recommended and appropriate amounts for each stage of the dentition, dental fluorosis can be avoided, as it will be expelled enough for a brushing effective.

IV. RESULTS AND DISCUSSION

The object of study is the fluoride of toothpaste. The research was done on the best way to expel a quantity that the main focus is the consumer (child) user, who sometimes ends up ingesting more toothpaste than usual. A table was created, thinking that a child has three daily brushings, as dentists recommend. They are considering the clinically acceptable dose of 0.05 to 0.07 mg of F/kg of weight per day. There was a stalemate of the value to be used and to obtain more security, aligned to an appropriate amount of volume to perform the brushing. The quantity of toothpaste recommended for brushing and not ingesting doses above the clinically accepted rate was 0.023 mg F/kg of weight per day, for each brushing, based on the three daily brushings recommended.

So if the child brushes with this prototype more than three times a day, because he has other fluoridated sources, he will exceed the clinically acceptable dose of 0.05 to 0.07 mg of F/kg of weight per day. The quantity found in this prototype, thinking that the child may ingest all toothpaste. If the child swallows the three doses daily so that he will not contract dental fluorosis, as it is within the quantity clinically acceptable, that can be ingested per day.

The best way to prevent contracting the pathology is for those responsible for alerting children to the correct use of toothpaste. The problem is not to brush your teeth with fluorine, but to be ingested frequently. After all, applying teeth brushing with fluoride toothpaste from a young age is one of the main barriers against tooth decay. The calculation occurs in such a way that the maximum amount of fluoride that ingested per application is established concerning contract the pathology (Eq. 1).

Equation 1.

$$M = \frac{\frac{D \times P}{1000}}{ppm}$$

D = standard dosage of 0.023 mg of F/kg of weight/day which will be a constant and were expressed in the calculation in grams;
P = child's weight and were shown in the calculation in grams;
ppm = parts per million of fluoride in the toothpaste and were expressed in the count in parts per million;
M = maximum amount of fluoride that can be ingested per dose to avoid contracting the pathology.
The maximum rate that the child can ingest fluoride daily was obtained based on the following data:
Child weight:

➢ The weight of children 1 to 6 years old ranges from 6.3 to 33.4 kg;

✓ But for the calculations we use values between 7 to 35 kg;

Parts per million of toothpaste:

➢ The total fluoride of toothpaste packaging ranges from 600 to 1500 ppm;

✓ But for our calculations, we use values between 500 to 1500 ppm of fluoride.

Thinking about the best method of use for brushing and based on studies that explain the mass to use is a measure equal to a pea mass of mass ± 0.22 g of toothpaste. We opted for our prototype to expel this quantity, and we discard all other values below this margin.

Values above that can then be used equally to 0.22 g. To calculate the density, a survey occurs among the brands of toothpaste that contained the quantity in grams and milliliters of toothpaste in the description of their packaging labels. Different brands were identified, identified by A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, and P.

A - No label contained the two information together of the quantity in mass and volume;
B - No label contained the two information together of the quantity in mass and volume;
C - No label contained the two information together of the quantity in mass and volume;
D - No label contained the two information together of the quantity in mass and volume;
E - A label contained the two information together of the quantity in mass and volume;
F - Seven labels contained the two information together of the quantity in mass and volume;

G - No label contained the two information together of the quantity in mass and volume;
H - No label contained the two information together of the quantity in mass and in volume;
I - No label contained the two information together of the quantity in mass and in volume;
J - No label contained the two information together of the quantity in mass and in volume;
K– Two labels contained the two information together of the quantity in mass and in volume;
L - No label contained the two information together of the quantity in mass and in volume;
M - No label contained the two information together of the quantity in mass and in volume;
N - No label contained the two information together of the quantity in mass and in volume;
O - No label contained the two information together of the quantity in mass and in volume;
P - No label contained the two information together of the quantity in mass and in volume.

The outcomes result in the labels tabulated by-product, gram, milliliter, respectively. Based on these values, the density can be calculated by performing the density calculation (Eq. 2).

Equation 2.

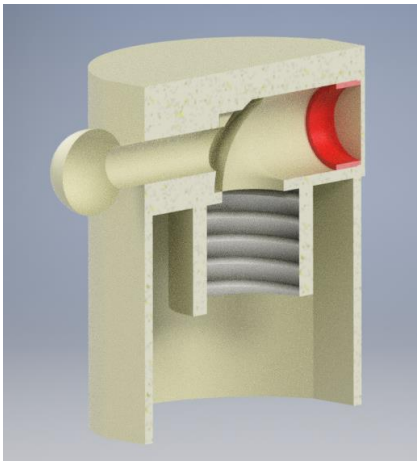
$$D = \frac{g}{mL}$$

D = density of toothpaste expressed [g/cm^3];
g = quantity in grams contained within the tube [g];
mL = volume contained in the tube that expressed [cm^3].

For a safety measure, the highest value of the toothpaste density found was adopted, which was toothpaste F with 1.37 g/cm³. To find the amount to be expelled by the prototype, a simple rule of three was used. The value of 0.22 g was used, resulting in a 0.166 □□³.

To determine the flow of toothpaste that the product will expel by dosing, it was based on the volume of the cylinder concerning its height, which in turn is equal to the distance from the stem. In the sketch below, the amount in red with a diameter of 8 mm and height equal to the displacement that the stem will perform since the distance displaced by the stem is the same that will be replaced in the volume inside the container. To determine the distance value, the cylinder volume was calculated, considering 0.16 cm³ that should be expelled from toothpaste (Fig. 1).

Figure1. Volume of toothpaste to be displaced.



Using the formula for the volume of a cylinder to obtain the height with (Eq. 3).

Equation 3.

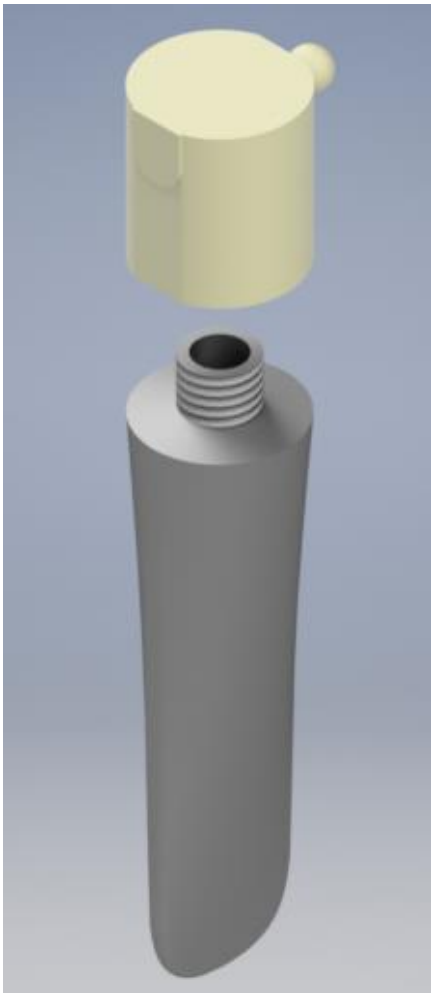
$$h = \frac{V}{\pi \cdot r^2}$$

V = cylinder volume [cm^3];
π = irrational mathematical constant;
r = radius of the circumference [cm];
h = [cm].

Based on the formula, the displacement value of the nail occurred. The first step to be followed is to look at the percentage in ppm of fluoride in the packaging of the toothpaste to be used and to take into account the weight of the child who will use the prototype.

Then remove the thread of the original cap of the toothpaste and fit the thread of the prototype, lifting the cap and pushing the stem, making an analogy with a syringe (Fig. 2).

Figure2. Cap designed for dosing toothpaste.



V. CONCLUSION

We concluded that the project reached its proposed objectives to eliminate the fluoride intake of the toothpaste above the acceptable level, thus not contracting the pathology. It was possible to see, through the virtual prototype, that the general objective of the project managed to make the value displaced by the stem lower than the maximum amount of swallowing fluoride, considering the daily rate of three brushings to combat the pathology. In addition to the rod, the table to indicate the possibility of using the prototype has also achieved its objectives of being able to inform those responsible if it is suitable for use with the fluoride versus weight daily use standards is the individual's requirements to use it.

The cover of the toothpaste had its satisfactory result. The choices of toothpaste density, prototype material, and thread were achieved. The main focus of the project was the dimensioning of the volume to be placed in the fluoride toothpaste for brushing, which was made and thus showed to eliminate the pathology if used correctly.

ACKNOWLEDGEMENT

This study is part of projects of a group of researchers of Teachers and Mechanics Students of the Fundação Escola Técnica Liberato Salzano Vieira da Cunha (http://www.liberato.com.br/) from Novo Hamburgo, Brazil. The research group does not receive any funding to support it.

REFERENCES

[1]. A. M. L. Pedersen, M. Darwish, J. Nicholson, M. I. Edwards, D. Belstrøm, Gingival health status in individuals using different types of toothpaste, Journal of Dentistry, vol. 80, Supplement 1, 2019, pp s13-s18. DOI: 10.1016/j.jdent.2018.08.008

[2]. M. Vertuan, B. M. de Souza, P. F. Machado, V. Mosquim, A. C. Magalhães, The effect of commercial whitening toothpastes on erosive dentin wear in vitro, Archives of Oral Biology, vol. 109, 2020, DOI: 10.1016/j.archoralbio.2019.104580

[3]. L. Jarquín-Yñezá, J. Al. Alegría-Torres, C. G. Castillo, J. de J. Mejía-Saavedra, Dental fluorosis and a polymorphism in the COL1A2 gene in Mexican children, Archives of Oral Biology, vol. 96, 2018, pp 21-25. DOI: 10.1016/j.archoralbio.2018.08.010

[4]. P. DenBesten, W. Li, Chronic fluoride toxicity: dental fluorosis. Monogr Oral Sci. 2011; 22:81-96. DOI: 10.1159/000327028

[5]. G. Zhou, L. Yang, C. Luo, H. Liu, A. Wang, Low-to-moderate fluoride exposure, relative mitochondrial DNA levels, and dental fluorosis in Chinese children, Environment International, vol 127, 2019. pp 70-77. DOI: 10.1016/j.envint.2019.03.033

[6]. J. Yang, M. Wang, J. Lu, K. Yang, M. Liu, H. Luo, L. Pang, B. Wang, Fluorine in the environment in an endemic fluorosis area in Southwest, China, Environmental Research, vol. 184 2020. DOI: 10.1016/j.envres.2020.109300

[7]. M. E. Irigoyen-Camacho, A. García Pérez, A. M. González, R. H. Alvarez, Nutritional status and dental fluorosis among schoolchildren in communities with different drinking water fluoride concentrations in a central region in Mexico, Science of The Total Environment, vol. 54115, 2016 pp 512-519. DOI: 10.1016/j.scitotenv.2015.09.085

[8]. C. M. Viegas, A. C. Scarpelli, J. B. Novaes Júnior, S. M. Paiva, I. A. Pordeus, Fluorose dentária: abordagens terapêuticas para recuperação estética [in portuguese]. RGO - Rev Gaúcha Odontol. Porto Alegre, v.59, n.3, p.497-498, jul./set., 2011.

[9]. R. Otsuka, Y. Nomura, A. Okada, H. Uematsu, M. Nakano, K. Hikiji, N. Hanada, Y. Momoi, Properties of manual toothbrush that influence on plaque removal of interproximal surface in vitro, Journal of Dental Sciences, vol. 15, n. 1, 2020. pp 14-21. DOI: 10.1016/j.jds.2019.07.005

[10]. S. Corbella, F. Tramontano, B. Zotti, M. Muzzarelli, A. Alberti, L. Francetti, Influence of teeth anatomical characteristics on the efficacy of manual toothbrushing manoeuvres, The Saudi Dental Journal. 2019. DOI: 10.1016/j.sdentj.2019.10.008

[11]. M. Kuwabara, Y. Motoki, H. Sato, M. Fujii, Y. Nakamura, Low frequency of toothbrushing practices is an independent risk factor for diabetes mellitus in male and dyslipidemia in female: A large-scale, 5-year cohort study in Japan, Journal of Cardiology, vol. 70, n. 2, 2017, pp 107-112. DOI: 10.1016/j.jjcc.2016.10.008

[12]. C. Death, G. Coulson, U. Kierdorf, H. Kierdorf, W. K. Morris, J. Hufschmid, Dental fluorosis and skeletal fluoride content as biomarkers of excess fluoride exposure in marsupials, Science of The Total Environment, vol. 53315, 2015. pp 528-541. DOI: 10.1016/j.scitotenv.2015.06.054

[13]. A. C. de Mattos, J. P. S. de Matos, J. M. R. Simão, G. S. L. Alves, A. Giacomin, J. de Souza, Desenvolvimento de cadeira escolar ergonômica com ajuste para medidas antropométricas físicas Brazilian Journal of Development Vol. 6, n. 4, p, 19381 -19405 (2020) DOI: 10.34117/bjdv6n4-199

[14]. M. L. Pohren, N. M. Carbonari, F. R. de O. de Souza, J. de Souza Estudo e projeto de tecnologia para transferência e movimentação de tetraplégicos Brazilian Journal of Development Vol. 6, n. 4 Pp 20998-21016 (2020) DOI:10.34117/bjdv6n4-320

[15]. E. R. Rabaioli, E. de O. Scheitt, G. S. L. Alves, A. Giacomin, J. de Souza, Promoting Urban Mobility: Bus Crutch Support Project American Journal of Engineering Research (AJER) Vol. 9 - n. 05, Pp 52-55 2020

Guilherme Augusto Alles, et. al. "Sealing cap for the toothpaste enclosure with the amount of archetype expelled for children in the formation of the dental germ." *International Journal of Engineering and Science*, vol. 10, no. 07, 2020, pp. 11-16.