

Fluorides: The Anticaries Balm or Esthetic Nightmare?

A Structured Global Review – Risks Verses Benefits and Recent Advances

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Abstract

Objective: To make a current and latest review of the knowledge in domain of utility of the fluorides at global, regional and local level.

Methodology: The authors looked at all the studies that are found on PubMed from 2000 until now, after that we excluded all the studies that are not related and relevant to our review. Such literature reviews save time of the practitioners in making a wholesome reading of vast material in short time.

Results: Results from a total of 29 citations, we found 17 / 29 [58.62%] references that talk negatively about the effect of the fluorides on our teeth in special and our body in general, but 7 / 29 [24.13%] mention positive impact of fluorides.

Conclusion: It is concluded that countries in which the quality of the drinking water may be compromised due to evaporation of warm summers, leaching of pesticides into ground water and in areas where inherently there is high levels of fluoride and the role of cooking which may concentrate the fluoride, it is better to use fluoride varnish and local application in clinics so that the toxicity of higher levels of fluoride may be obviated.

Keywords: Fluoride; Water Fluoridation; Fluorosis; Dental Caries; Global

Introduction

Fluorides are naturally occurring salts in nature, over the years two schools of thoughts have emerged, one supporting the usage of fluorides unequivocally and another protesting that chemicals should not be used without the consent of the people which has effectively blocked the usage of fluoride in many countries, notably Austria, Belgium, Germany, Sweden, Norway and the Netherlands.

In Europe, only Ireland (73%), Poland (1%), Serbia (3%), Spain (11%), and the U.K. (11%) fluoridate their water supplies according to the Fluoride Action Network [1].

The old and non-scientific opinion was that fluoride in drinking water and paste was detrimental to health of humans [2]. The new idea which we support by science and evidence is that the fluoride used locally and systematically in correct proportion is beneficial to the hard tissues of oral cavity namely enamel, dentin and cementum [3].

And help to prevent the caries in the teeth. The caries process destroy teeth due to the bacterial attack utilizing the dental and interdental sugars in oral cavity [4].

A Mexican reference [5] has highlighted that amongst adolescents the high fluoride levels result in ugly teeth due brownish discoloration may result in the psychosocial distress due to peer bullying.

In this review, we will look at pertinent global references to give us a balanced view of use and abuse of fluoride.

Methodology

The authors looked at all the studies that are found on PubMed from 2000 until now, but some references were in the older time period, and we added it because they have historical importance. after that we excluded all the studies that are not related and relevant to our review. Such literature reviews save time of the practitioners in making a wholesome reading of vast material in short time.

Results

Results from a total of 29 citations, we found 17/ 29 [58.62%] references that talk negatively about the effect of the fluorides on our teeth in special and our body in general, but 7 /29 [24.13%] mention positive impact of fluorides. The remaining citations 5/29 [17.25%] give an idea about the mechanisms of fluoride toxicity and how we can measure it.

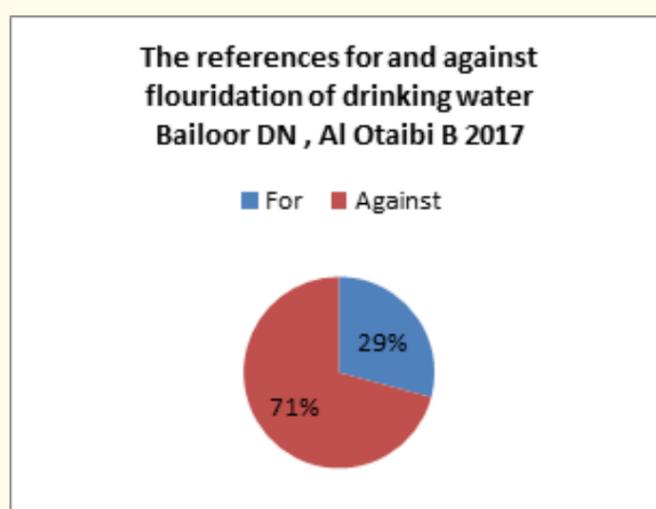


Figure 1: Shows the total number of references for and against flouridation of the drinking water 2017.

A major part of references opined that fluoridation of drinking water must be done with extreme care, and weather conditions must be considered before making a policy of putting the fluorides.

| The listing of positive and the negative opinions about the fluoridation of drinking water in our review April 2017 | | | | | | | |
|---|--|--|---------|------|--|---------|------|
| Methods and Mechanisms | | Positive | Ref. No | Year | Negative | Ref. No | Year |
| Dean HT [10] 1942 | Dean Index – method of fluorosis | Mullen J | 1 | 2005 | Mascarenhas AK | 2 | 2000 |
| Fejerskov O [12] 1990 | Severity of dental fluorosis | National health and medical research council | 3 | 2007 | Molina-Freshero N | 5 | 2017 |
| McGrady [14] 2012 | Flourescence imaging and Remote Photographic Scoring | Peterson PE | 4 | 2004 | National Institute of dental and craniofacial research | 6 | 2013 |
| Whitford [19] 1989 | Mechanism of Fluoride toxicity | Archer NP | 25 | 2016 | Ruan JP | 7 | 2005 |
| Melvor [20] 1987 | Hyper kalemia and fluoro-sis | Bucchamar EE | 26 | 2012 | Ayoob S | 8 | 2006 |
| | | Yang YP | 27 | 2015 | Beltran-Aquilar ED | 9 | 2010 |
| | | Glattre E | 28 | 1979 | Hong L | 11 | 2006 |
| | | 24.13% of the references above supported the fluoridation in drinking water unequivocally. | | | McGrady MG | 13 | 2012 |
| | | | | | Almerich-Silla JM | 15 | 2008 |
| | | | | | Horowitz HS | 16 | 1989 |
| | | | | | Firempong CK | 17 | 2013 |
| | | | | | Li L | 18 | 2003 |
| | | | | | Khalid A | 21 | 2004 |
| | | | | | Alhobeira HA | 22 | 2015 |
| | | | | | Khan SQ | 23 | 2015 |
| | | | | | Al Dosari AM | 24 | 2010 |
| | | | | | Do LG | 29 | 2016 |
| The six references No 10, 12, 16, 19, 20 and 28 were in the older time period, but they have historical importance and hence were included. | | The relationship between the cancer and fluoride levels is very tenuous. The Chinese reference Yang YP [27] gives us a hint that in Aluminium industry the males had liver and lung, and females had breast and lung cancer high risk. | | | The above mentioned references were 58.62% of these references stated that it was not a good idea to do fluoridation of the drinking water due to pesticide poisoning, evaporation of water in summer which resulted in high concentrations, cooking which increased the concentration, and ground water having a very high level of fluoride. | | |

Table 1: The chart which shows the general trend of opinion about drinking water fluoridation in this series. [Bailoor DN, Al Otaibi B., et al. 2017].

Discussion

In 1900s, there was a dentist named Frederick McKay, observed that a lot of brown staining on the teeth of Colorado natives.

After his investigation, McKay persuaded G.V. Black to complete their analysis, and the end of their research they found the fluoride was the cause of two statements: firstly, statement was the brown stains, " as what is known by fluorosis nowadays", the another one is the highly resistant of the affected individuals to the tooth decay [6].

From this point, the researchers take a different two direction in the effect of the fluoride on the oral health generally and on the health of teeth specially, the first way was on the risk of the fluoride on the teeth esthetically and the following problems that can be occur.

In the areas that dentist practiced he must ascertain that the drinking water does not have normally or naturally high levels of Fluoride like greater than 3 or 4 ppm. In case it is so then the doctor should not use fluoride paste or application recommendation for his patients.

Ruan JP, *et al.* [7] have stated that the levels of fluorides in drinking water will affect the deciduous teeth, also with those are completed their mineralizing process in the uterus, and that can be a biomarker for an excessive fluoride dose, and it can help us to reevaluate the fluoride levels in drinking water even in areas with less than 1.0 mg L⁻¹ of fluoride concentrations [7]. The teeth which are fully mineralized even before birth show some levels of fluorosis indicating that the placenta may not be an effective barrier to the exposure to fluoride ions [7].

Moving to India, one of researchers said that the fluorides in drinking water is act as a barrier against the caries process, however it increase the probability of fluorosis to occur specially for the people with low socioeconomic state, and it can extent to a bigger problems such as a lot of genetic defects and some kinds of cancers like a osteosarcoma, and according to that we should to rely on a topical applications with a minimum doses to prevent the decay, and look again to this situation with more awareness to this problem that is rooted in a lot of areas around the world [8].

In US on the other hand, Beltran-Aguilar ED, *et al.* [9] who have done the study from CDC (centers for disease control) from US found that when they compared the two-time periods 1999 - 2004 with the prevalence of fluorosis in 1986-87.

Very mild fluorosis – increase from 17.2% to 28.5%

Mild fluorosis – increase from 4.1% to 8.6%

Mod and severe – 1.3% to 3.6%

This may be the reason that many of the non-professional bodies who govern the municipal and state Government departments of health have started questioning whether the drop in caries was a good payoff towards higher levels of fluorosis. This study used the Deans index developed by H T Dean in 1930 [10] and is even used today by the various professionals.

The fluorosis problem of esthetics will be governed by when the fluoride was ingested and at what doses [11]. The linear relationship of the severity of dental fluorosis and the dose of the element has been confirmed again by the study of Fejerskov O [12] As per the Thailand study McGrady suggested that the levels of fluoride in the cooking water increased significantly due to the boiling and water being lost in steam. His observation was from 0.9 ppm [parts per million] it increase to 1.6 ppm. They also matched the infant feeding and tooth brushing practices in 560 patients who were also photographed for changes of fluorosis in all these persons. They emphasized that all the possible sources of the fluoride salt should be considered when any effects are being studied [13].

McGrady has further suggested that [14] amongst the two methods of assessing the clinical fluorosis the method, Fluorescence Imaging was more standardized than remote photographic scoring and he suggested that the objective quantification was of greater repeatability for research specially observational epidemiology.

Almerich-Silla JM, *et al.* [15] did a phenomenal study amongst the refugee children from Algeria and other western Saharan countries and found that the levels of Fluoride more than 2 ppm resulted in increasing levels of caries. This was explained by authors that these children faced very adverse conditions of unbalanced diet, poor oral hygiene habits and very high fluoride concentration in the water available in the refugee camp.

Horowitz HS [16] observed that fluorosis was more prevalent in permanent dentition as compared with primary teeth and they concluded this by observing that children in age group of 11-13 years had more severity of fluorosis as compared with the same sample of age 6 - 7 years. This is in contrast to the work of Ruan JP in which they state that the placenta does not afford any protection to the pre-birth mineralization of deciduous teeth [7].

Firemping CK, Nsiah K., *et al.* [17] has clinically evaluated 200 children for the prevalence of fluorosis in Bongo district, Ghana and found very high levels at 63% in contrast the surrounding villages showed just 10%. They attributed this aberration to the high levels of fluorides in underground water and suggested that the government prevent the people from using this source and that the population must be provided with alternative untainted drinking water. Li L [18] found that where insecticide and rodenticide poisoning was reported in the population acute fluoride toxicity was found.

Mechanism of action of fluoride toxicity

In a classical monograph by Whitford GM [19] and Melvor ME [20], the mechanism of fluoride toxicity have been explained in the following ways:

1. Fluoride ions act locally on intestinal mucosa by formation of hydrofluoric acid leading to nausea, vomiting, diarrhea and abdominal pain.
2. In the serum hypo calcaemia may result due to binding between fluoride and calcium ions.
3. Enzyme system disruption – The oxidative, Phosphorylation, glycolysis, coagulation and neurotransmission are all disturbed by the high fluoride ions.
4. Fluoride inhibits acetylcholinesterase resulting in hypersalivation, vomiting, and diarrhea.
5. Seizures have been reported due to lowered levels of magnesium and calcium in the serum.
6. Central vasomotor depression causes damage to cardiac muscles and fatality may result from additional respiratory paralysis.

Gulf Country Studies

Khalid A in his study from Qatar [21] found that 55.29% of the persons aged 8 - 50 were suffering from dental fluorosis and his study comprised of 4800 nationals from and around Doha. Since this study shows that more than 50% of the general population has esthetic problem due to some level of fluorosis and he recommend that more studies be done to correlate the drinking water, cooking water and other sources of fluoride and then suggest a solution to it.

The study from Hail Saudi Arabia suggested that the prevalence levels were 73.5% more higher than the Qatar study, but the sample size of the Hail study was comparatively small 253 and males showed 70% and the females had higher levels at 77.6% [22].

The other study from Dammam by Khan SQ, *et al.* [23] has shown that prevalence of fluorosis was 33% in the mixed population of Pakistani, Indian and Saudi Children. This prevalence is much lower than the previous study from Hail, because the sampling is not local but international the number is slightly higher (496) and to our surprise this study portrays males having higher prevalence [male = 37.45% female = 28.27%] as compared to Hail study which appears to be more reliable figure for Saudi Population. The influence of international population has lead to skewness of the prevalence to the lower side and hence it cannot be accepted as true figure for Saudi population.

Al Dosari AM, *et al.* [24] analyzed 3629 water samples in 11 regions of Saudi Arabia and correlated with the teeth of 12, 200 children at various levels of primary, elementary and secondary and found that between 0.3 ppm and 0.6 ppm no significant difference was seen in the dental decay and dental fluorosis. However, in the region of more than 0.6ppm the fluorosis was more and Cares experience was less. They mentioned that the levels 1.01 - 1.50 ppm of fluorides resulted in maximum levels of fluorosis in this series. Binary logistic regres-

sion study shows that association between the fluoride exposure and the dental caries was seen significantly only when the fluoride levels were more than 1.00ppm.

Tenuous link between fluoride and cancer

Relationship was postulated between the levels of fluoride in environment and cancers of different anatomical location in human body.

Archer NP, *et al.* [25] found no link between the fluorides in public drinking water and childhood and adolescent osteosarcoma in Texas, US.

Buchhamer EE, *et al.* [26] who worked in Chaco, Argentina found that levels of Arsenic and Fluoride were high in ground water and this lead to a high incidence of fluorosis in 42% of the population and the combined exposure to Arsenic to level of 95 µg/L [safe 10 µg/L] in shallow water and 90 µg/L in deep water. The fluorosis and an apparent high risk of cancer may be linked with these two salts in this region. However, a definitive link was not established.

A Chinese study by Yang YP, *et al.* [27] studied the fluoride exposed workers in Aluminium industry and found males to have increased incidence of Liver and Lung cancer and females workers were more at risk for Breast and Lung. They calculated the odds ratio to be 1: 2.14. The age of onset for these workers was also early ranging from 40 to 49 years. The Norway study by Glattre E, *et al.* [28] showed an inverse relationship between the fluoride levels and cancer of mouth and throat. This country has highly regulated levels of fluorides in the drinking water and the positive impact of fluorides at these levels. The confounding factors of genetics and tobacco consumption have been also touched upon suggesting that a more extensive research was to be done in near future.

Conclusion

Mild dental fluorosis becomes less with time and this did not have any impact of perception of oral health. While the levels of 0.3 ppm to 0.6 ppm are very beneficial, higher levels of fluoride become increasingly dangerous to health.

Levels above 1 ppm and reaching 2 ppm can result is severe fluorosis and levels higher than that can result in skeletal involvement [29]. After this level, increasingly toxicity sets in and it may cause mild symptoms like vomiting, diarrhea and acute gastro intestinal distress to moderate symptoms like hyper salivation, and even seizures. The severe component of this toxicity is damage to cardiac muscle and respiratory paralysis which may result in death.

It may be concluded from above discussions that in countries where underground water or evaporation due to heat can increase the ppm of fluorides, it may be suitable not to do the water fluoridation of drinking supply generally, since levels may be difficult to control. The mixing of pesticides can also result in very high levels of fluorides and needs to be detected in community. The Thai study also shows how cooking can amplify the fluoride levels in already high levels in water used. Thus, fluoride must be used clinically by doctor locally in the oral environment, in a controlled way, rather than in communities where the levels may be drastically increased by weather, leaching of pesticides or even different methods of cooking.

The link between fluoride levels in drinking water and fluorosis were established but no obvious link was determined between the levels of fluoride in drinking water and Cancer in this review. The aluminium industry appears to have a high risk of Liver, Lung and Breast cancer as per the study conducted on the labourers in Nanning, China and their exposure to different ions after the electrolysis process.

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