Review on Caries Preventive Effect of Fluoride Toothpaste

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Abstract

Dental caries is defined as localized destruction of tooth tissue, mainly due to bacterial action causing demineralized foci on peripheral surfaces. Normally, children have the habit of brushing their teeth once a day using fluoridated toothpaste. Due to this,there is less decay of tooth in them, as fluoride being a mineral prevents tooth decay. There is a relationship between fluoride toothpaste and dental caries, if a toothpaste having 1000ppm of fluoride content, is associated with less decay of tooth, so the fluoride has caries preventive effect. The aim of the review is to find out the role of fluoride in caries preventive effect, to know fluoride toothpastes correct concentration to avoid fluorosis and other fluoride related ailments and finally to understand the advantages of fluoride toothpaste as preventive effect of dental caries. This research was conceived as scoping literature review. This review has accessed existing reviews and researches in the last decade mostly, through PMC database, MeSH, Google Scholar, Pubmed, Medline, CrossRef and the search terms included were 'dental caries', 'fluoride toothpaste', 'caries preventive effect', 'fluoride'. Considered research was limited to manuscripts related to English, dental caries, fluoride toothpaste (as caries preventive effect) and this review did not include or consider other oral problems, other preventive methods of dental caries, natural components that prevent caries attack. The description of included studies for the review is tabulated. The role of fluoride in dental caries, its correct concentration in fluoride toothpaste is known and the preventive effect of fluoride toothpaste on dental caries is well understood through this review. With these general guidelines, there is more possibility of preventing dental caries and excessive fluoride will not lead to fluorosis due to awareness of correct concentration of fluoride in fluoride toothpaste.

Keywords: *Dental caries; fluoride toothpaste; caries preventive effect; fluorosis.*

Introduction

Dental caries is defined as localized destruction of tooth tissue, mainly due to bacterial action causing demineralized foci on peripheral surfaces [1]. Normally, children have the habit of brushing their teeth once a day using fluoridated toothpaste. Due to this,there is less decay of tooth in them,as fluoride being a mineral prevents tooth decay [2]. There is a relationship between fluoride toothpaste and dental caries, if a toothpaste having 1000ppm of fluoride content, is associated with less decay of tooth, so the fluoride has caries preventive effect [3]. Methods of fluoride use may be different like fluoridated water, milk, varnish,etc and there are many methods of use but for classification, should be community based, individual based, professional based. By knowing this, we can give absolute fluoridated treatment for caries prevention. There was wrong classification as systemic and topical use which is now not considered, because the new classification gave better scope of treating /preventing caries [4,5] .

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The previous research by Gail Topping and Andrea Assaf,2005 [6], has concluded that daily use of fluoridated toothpaste in young permanent dentition should be more than 1500ppm. The study observed that fluoride toothpaste more than 1500ppm have superior caries preventive effect, and has also observed that caries preventive effect is higher in supervised brushing. Another research by Valeria CC Marinho,2004 [7], has concluded that topical fluorides in addition with fluoride toothpaste has modest reduction in dental caries, so both fluoride applications have better enhancement than using only fluoride toothpaste.

The limitation of most previous researches on this topic of review is that they have given effect of fluoride toothpaste mostly in children. The fluoride toothpaste effect is not discussed /studied in other age groups, like in adolescents. The dental caries preventive effect is not studied in most caries susceptible populations, even not in different regions, locality, different temperature, altitudes is not provided. Dental caries is once a problem mainly, as of now it is a rising problem above all age groups. So, there is a need to know the prevention method. The most used preventive measure is fluoride toothpaste which is of low cost remedy to prevent dental caries. The aim of the review is to find out the role of fluoride in caries preventive effect, to know fluoride toothpastes correct concentration to avoid fluorosis and other fluoride related ailments and finally to understand the advantages of fluoride toothpaste as preventive effect of dental caries.

Methodology

This research was conceived as scoping literature review. This review has accessed existing reviews and researches in the last decade mostly, through PMC database, MeSH, Google Scholar, Pubmed, Medline, CrossRef [8–13] and the search terms included were 'dental caries', 'fluoride toothpaste', 'caries preventive effect', 'fluoride'. Considered research was limited to manuscripts related to English, dental caries, fluoride toothpaste (as caries preventive effect) and this review did not include or consider other oral problems, other preventive methods of dental caries, natural components that prevent caries attack. The period of duration considered is 1965 to 2020. The total number of articles found on typing the topic is 62,200 and the number of articles actually relevant to the topic is 84 found by searching using keywords. The number of research articles that are used in writing the review is 45. Quality of articles used was assessed using Quality assessment tools and graded as strong, moderate and weak. The level of evidence of the reviewed articles were categorised according to the criteria of Centre for Evidence-Based Medicine, Oxford, UK [14].

DENTAL CARIES

Introduction of Dental Caries

Dental caries is defined as localized destruction of tooth tissue by bacterial action causing demineralized foci on the peripheral surface of enamel [1]. It can also be defined as localized demineralization of hard tissues of teeth by action of acid derived from food debris or sugar [15]. This is due to dissolution of hydroxyapatite crystals which results in loss of organic matrix of both enamel and dentin [16].

Causes of Dental Caries

Streptococcus mutans is the main cause for dental caries which leads to formation of plaque biofilm. This plaque biofilm ensures caries development in any individual [17]. Actually, dental caries are due to the presence of four variables such as cariogenic bacteria (caries producing bacteria, like S.mutans), sugar(carbohydrate fermentation also causes dental caries), susceptible tooth surface and time. The variables are most important to know for the cause of caries attack [18]. Dental caries is due to localised destruction of bacterial fermentation of dietary carbohydrates. It has factors also like ecological imbalance, physiological equilibrium, as sugar is also a main variable considered here [19].

Prevention of Dental Caries

Preventive factors such as salivary calcium, phosphate and proteins present in salivary flow helps in prevention of dental caries. Presence of a small amount of fluoride in saliva acts as antibacterial agents [20]. New possible advanced preventive method is by CO_2 laser. Irradiation of enamel by CO_2 alters the hydroxyapatite crystals and reduces activity. The CO_2, laser treatment along with fluoride treatment is found to be more beneficiary [21]. Fluoride is the most effective material in

control of dental caries. The other methods of fluoride use can be fluoride toothpaste, fluoride mouth rinse which can be easy to use for any individual [22]. Recent study for caries prevention is by grape extract. The grape extract has bacteriostatic activity and also has collagen crosslinking properties which will help in tooth remineralisation [23]. Other than CO_2 laser treatment, whitening LED is used. It reduces the growth of Streptococcus mutans which ultimately prevents dental caries. This treatment will allow full arch irradiation [24].

FLUORIDES PREVENTIVE EFFECT

Fluoride's Role in Dental Caries

Fluorine combines with free hydroxyapatite crystals in enamel. It then forms fluorohydroxyapatite which gets redeposited in enamel. This will form protective covering over the enamel. This leads to prevention of dental caries [22].

Previous Research on Preventive Effect

Children normally brush their teeth once a day using toothpaste with fluoride. It showed less decay effect which was studied by Valeria CC Marinho, etal,2003 [2]. Another study by Tanya Walsh, etal,2010 [3] has concluded that toothpaste with 1000ppm of fluoride is associated with less tooth decay. The study was effective to know the correct concentration of fluoride content in toothpaste. Supporting the above studies stated, study by Gail Topping and Andrea Assaf, 2005 [6] has concluded that daily use of fluoride toothpaste in young permanent dentition with more than 1500ppm has superior preventive effect on caries. All of the previous studies considered a range of 1000ppm-1500ppm would be the correct concentration of fluoride content in fluoride toothpaste for the best caries preventive effect.

Fluoride Toothpaste

The topical fluorides in addition with fluoride toothpaste will give modest reduction of caries. So, it is advised that not only fluoride toothpaste will help you out of caries, it needs some additional application to have long lasting, superior preventive effect [7]. To know the relationship between fluoride toothpaste and caries, is that if lower fluoride formulations will have lower risk of fluorosis which is balanced, but it will have higher risk of caries. So, more fluoride formulation means lower risk of caries attack [25]. Fluoride toothpaste, lactate ion, polyvinylmethylethermaleic anhydride, all of these help in enamel remineralisation [26].

OTHER MEANS OF FLUORIDE USE

Other Methods

Methods of fluoride use are classified as systemic,topical,community based,individual and professional based. Different methods will be water fluoridation, fluoride mouth rinse,salt fluoridation,milk fluoridation. There are many methods of fluoride use, which will help us to prevent caries [27]. These methods might prevent further periodontal diseases [28].

Fluoride Varnish

Fluoride varnish is more frequently used nowadays. It may not provide additional caries protection but has relatively low caries activity [29]. Fluoride varnish prevents occlusal, proximal, smooth surface caries. So fluoride varnish can also be used as an application but does not have a superior preventive effect for caries [30].

Results and Discussion

Table 1: Description and quality of included studies

S.NO	Author	Year	Quality of study	Key points	Level of evidence
1	Burnett G.W, etal	1968	Moderate	Dental caries is defined as localized destruction of tooth tissue, mainly due to bacterial action causing demineralized foci on peripheral surfaces.	Level 3
2	Silk H	2014	Moderate	Dental caries is defined as localized demineralization of hard tissues of teeth by action of acid derived from food debris or sugar.	Level 3
3	RJ Gibbons	1975	Strong	Dissolution of hydroxyapatite crystals which results in loss of organic matrix of both enamel and dentin.	Level 1
4	Qiuxiang Zhang, etal	2019	Strong	Streptococcus mutans is the main cause for dental caries which leads to formation of plaque biofilm.	Level 1
5	BA Kassim, etal	2006	Strong	Dental caries are due to the presence of four variables such as cariogenic bacteria, sugar,, susceptible tooth surface and time.	Level 2
6	Robert H Selwitz Dr, etal	2007	Weak	Dental caries is due to localised destruction of bacterial fermentation of dietary carbohydrates. It has factors like ecological imbalance, physiological equilibrium.	Level 5
7	John DB	2000	Moderate	Preventive factors such as salivary calcium, phosphate and proteins present in salivary flow helps in prevention of dental caries.	Level 3
8	Lidiany Karla Azevedo Rodrigues, etal	2004	Moderate	Irradiation of enamel by CO2 alters the hydroxyapatite crystals and reduces activity.	Level 3
9	Haiyang Sun, etal	2020	Strong	The other methods of fluoride use can be fluoride toothpaste, fluoride mouth rinse which can be easy to use for any individual.	Level 2
10	Delimont, etal	2019	Strong	The grape extract has bacteriostatic activity and also has collagen crosslinking properties which will help in tooth remineralisation.	Level 2

Cont... **Table 1: Description and quality of included studies**

11	Feng Luo, etal	2020	Strong	Fluorine combines with free hydroxyapatite crystals in enamel. It then forms fluorohydroxyapatite which gets redeposited in enamel. This will form protective covering over the enamel.	Level 2
12	Valeria CC Marinho, etal	2003	Strong	Children normally brush their teeth once a day using toothpaste with fluoride. It showed less decay effect.	Level 2
13	Tanya Walsh, etal	2010	Strong	Toothpaste with 1000ppm of fluoride is associated with less tooth decay.	Level 1
14	Gail Topping, Andrea Assaf	2005	Strong	Daily use of fluoride toothpaste in young permanent dentition with more than 1500ppm has superior preventive effect on caries.	Level 1
15	Holt RD, Murray JJ	1997	Moderate	If lower fluoride formulations will have lower risk of fluorosis which is balanced, but it will have higher risk of caries. So, more fluoride formulation means lower risk of caries attack.	Level 3
16	Liisa Seppa	1990	Moderate	Fluoride varnish is more frequently used nowadays. It may not provide additional caries protection but has relatively low caries activity.	Level 3
17	Jonathan E Creeth, etal	2020	Strong	Fluoride toothpaste, lactate ion, polyvinylmethylethermaleic anhydride, all of these help in enamel remineralisation.	Level 2
18	Ratilal Lalloo, etal	2020	Moderate	Fluoride varnish prevents occlusal, proximal, smooth surface caries.	Level 3
19	Valeria CC Marinho	2004	Strong	The topical fluorides in addition with fluoride toothpaste will give modest reduction of caries.	Level 2
20	Ellwood RP, etal	2008	Moderate	Different methods will be water fluoridation, fluoride mouth rinse,salt fluoridation,milk fluoridation.	Level 3
21	Choa Park, etal	2020	Strong	Whitening LED reduces the growth of Streptococcus mutans which ultimately prevents dental caries. This treatment will allow full arch irradiation.	Level 1

Dental caries is the localized destruction of bacterial action on the peripheral surface of enamel [1] and it is also localized demineralization by acid from food debris or sugar [15]. Main cause of dental caries is Streptococcus mutans which leads to formation of plaque biofilm. The L.Plantarum FBT9 has a stronger inhibitory effect on cariogenic bacteria [17]. The hot steeping extract of tea contains catechins which have a higher inhibitory effect on biofilms [31]. Lactobacillus fermentum Tc UESC01 is an antimicrobial agent against S.mutans. It is anti-adherent, and has bactericidal activity against planktonic cells of S.mutans [32]. Fluoride toothpaste should be of 1000ppm, has association with less decay [3] and more than 1500ppm, has superior preventive effect on caries [6]. Daily use of 0.2% sodium fluoride (NaF) mouth rinse is the most effective method. 0.05% NaF mouth rinse along with 1100 to 1500ppm in fluoride toothpaste [33] and 1100ppm of fluoride toothpaste for daily use is recommended [34]. So, normal range would be 1000ppm to 1500ppm in fluoride toothpaste to have better caries preventive effect. The abutments, implants, veneers are independent of dental caries [35 36 37,38], facial prosthesis and lip bumper prosthesis [39] does not give caries preventive effects [40] and also only restorations does not provide a remedy for caries [41]. Oral hygiene is very important during pregnancy, as it also affects the developing foetus and health of it [42].

The limitations of the present review is only recent studies have been included,the older studies were not included. The study populations of previous researches are different, as many factors are responsible for inducing dental caries. The review should consider a wide range of studies, considerations of other factors of dental caries, caries preventive effect of fluoride toothpaste with inclusion of population of systemic disease, non oral habit population and the study setting should be in particular region.

Future scope of the present review article is that many toothpastes (especially whitening toothpaste) have more fluoride content, which leads to toxicity. The normal range should be between 1000ppm and 1500ppm. This review will create an awareness of selection of toothpaste with correct fluoride concentration which is helpful in prevention of dental caries.

Conclusion

The role of fluoride in dental caries, its correct concentration in fluoride toothpaste was made clear and the preventive effect of fluoride toothpaste on dental caries is well understood through this review. With these general guidelines, there is more possibility of preventing dental caries and excessive fluoride will not lead to fluorosis due to awareness of correct concentration of fluoride in fluoride toothpaste.

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