

SYSTEMATIC REVIEW ON THE USE OF TITANIUM FLUORIDE VARNISH FOR CARIES PREVENTION**Surya Rajeev Nair¹, Sasikala M², Bharathwaj V V³, Sindhu R³, Prabu D⁴**¹Bachelor of Dental Surgery, SRM Dental College, Ramapuram, Chennai, India.²Master of Dental Surgery, Department of Public Health Dentistry, SM Dental Clinic, Tiruvallur, India.³Master of Dental Surgery, Senior lecturer, Department of Public Health Dentistry, SRM Dental College, Ramapuram, Chennai, India.⁴Master of Dental Surgery, Professor and Head, Department of Public Health Dentistry, SRM Dental College, Ramapuram, Chennai, India**Received: 07-09-2021 / Revised: 10-10-2021 / Accepted: 20-11-2021****Corresponding author: Dr. Prabu D****Conflict of interest: Nil****Abstract****Background:** Dental Caries has been the most prevalent disease in the world which affects all age group irrespective of gender. It can lead to a number of diseases in the oral cavity. Hence caries prevention is of utmost importance in today's world.**Aim:** To assess the efficiency of titanium fluoride varnish for caries prevention.**Methodology:** A literature review was performed using PubMed, science direct, Cochrane, Wiley online library using Mesh term "titanium fluoride varnish AND caries prevention". According to the prisma guidelines the mesh terms were altered in each search engines.**Result and Conclusion:** In the available literature, the use of titanium fluoride varnish was proven to be effective of caries prevention.**Keywords:** titanium fluoride varnish, caries prevention.**I. Introduction**

Dental caries is the most widespread disease of the oral cavity caused due to plaque containing various microorganisms. These microorganisms adhere to the tooth surface and keep growing. The main reason for microorganism's adherence on the tooth surface is due to the increased sucrose and carbohydrate content and low fluoride content. The prevalence of the disease has comparatively decreased over the years but

has not been completely eradicated. Fluoride compounds have been proven to reduce solubility in acidic conditions and promote remineralisation of tissues. [1]

Fluoride varnishes are a feasible approach for preventing and treating carious lesions at the individual level and in public health programs, due to its good cost-benefit compared to initial carious lesions restorations, when they eventually progress to

cavitation and have a significant negative impact in quality of life [2].the most commonly used fluoride compound is sodium fluoride varnish. Its only recently that titanium fluoride has been used as a varnish [3].

Sodium fluoride (NaF) is considered the “gold standard” therapeutic agent to control clinical appearance of dental caries [4] More recently, titanium tetra fluoride (TiF₄) has been investigated as an alternative topical therapeutic agent since it allies fluoride and titanium contents [4].

The use of fluoride varnish has been supported by a great number of investigations that have evaluated the enamel resistance to acid etching by increasing the fluoride incorporation in the enamel or by decreasing enamel solubility in acid. There are certain concentrations of fluoride (10, 50 and 125 ppm F⁻, 5 min/day) are effective in reducing acid production and acid tolerance as well as extracellular polysaccharide formation of *Streptococcus mutans* (*S. mutans*) biofilm[5].

The caries preventive action of fluoride is known to be due to the inhibitory effect of fluoride on matrix metalloproteinase [6]. Compared to toothbrush and other mechanical methods which are usually short term mechanical method its shown that high concentration of fluoride in varnishes and gel cause greater deposition of Calcium fluoride (to induce formation of apatite) [7]. Titanium fluoride alters the biomechanical and biochemical properties of dentin to promote its retention on tooth surface [8]. Some studies prove that titanium fluoride acts by modifying the smear layer hence can be used as a pre-treatment for caries prevention.[9]

The aim of this study is to check for the caries preventive nature of titanium fluoride varnish and to evaluate its ability to remineralise enamel.

Objectives:

To assess the use titanium fluoride varnish for caries prevention

Materials and Methods used:

Eligibility criteria:

Inclusions:

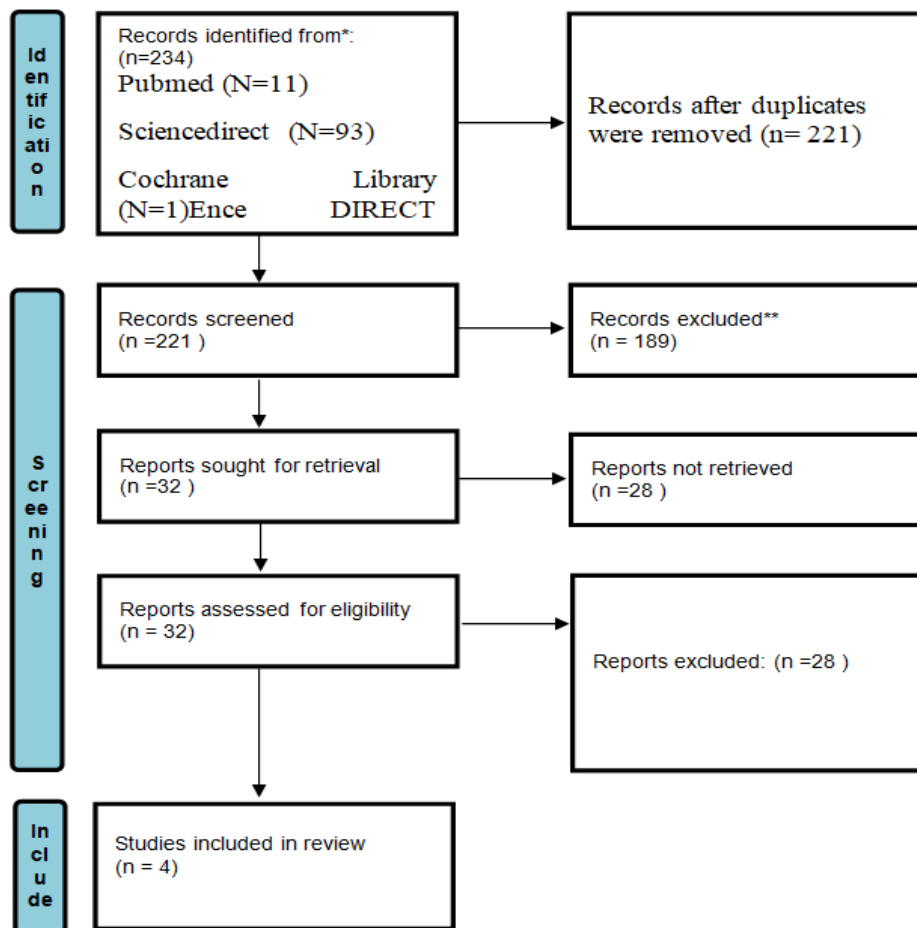
- i. Original articles
- ii. Full text articles
- iii. Studies which take titanium fluoride varnish as a measure for caries prevention.

Exclusions:

- i. Articles without full text
- ii. The studies which does not take titanium fluoride as a caries preventive measure
- iii. Studies which are in other languages were excluded

Search strategy:

Published results on use of titanium fluoride varnish for caries prevention which includes original articles and research papers in databases such as PubMed Central, Science direct, Cochrane Central Register of Controlled Trials (CENTRAL) were taken into study for review in March 2019. A literature search to collect relevant data was performed using Mesh terms “titanium fluoride varnish AND caries prevention”. According to the prisma guidelines the mesh terms were altered in each search engines.



Result

A literature review was performed using search engines. The key words used for the searching was “titanium fluoride varnish AND caries prevention”. A total of 234 articles from various search engines were collected and out of which 4 articles related to research topics were finalized. There were around 12 duplicates which were removed. Amongst the rest, the articles without full texts were also removed which lead to 32 articles. Out of the 32 articles, 4 were selected for final study purpose.

Figure 1: Showing The Number Of Datas Included For And Studies Taken For Qualitative Analysis.

Author	Year	Sample size	Group characterization	Intervention
ENRICO COSER BRIDI	2018	34 human	Group1: 2.5% varnish +CLE	TiF4 Duration: 21 days 64 cavities were made in the

et al		3 rd molar	<p>Group 2: 2.5% TiF4 varnish + SBU</p> <p>Group 3 : CLE</p> <p>Group 4: SBU</p> <p>They were also divided on the basis of depth of the outer tooth surface where indentation of 25µm, 50µm, 75µm, 100µm and the distance vertically away from the tooth-restoration interfaces where the indentations were performed: 50µm, 100µm and 150µm.</p>	<p>dentin enamel junction and were divided into the mentioned group. These cavities were restored with composite resins and were placed in intraoral palatal devices by 16 volunteers for 21 days to induce caries formation. Knoop microhardness test was performed on the cut fragments.</p>
PENG WANG et al	2017	60 human 3 rd molar	<p>Group 1: 1% TiF4</p> <p>Group 2: 2% TiF4</p> <p>Group 3: 3% TiF4</p> <p>Group 4: 4% TiF4</p> <p>Group 5: 2.172% NaF group</p> <p>Group 6: distilled deionized water (DDW)</p>	<p>Duration: 2 weeks</p> <p>60 sound human 3rd molar teeth were placed in diamond saw and cut. Two third of the specimen was kept uncovered while the remaining was covered using nail varnish. These were then divided into the mentioned 6 groups. Caries like lesions were induced. These were then observed by microCT, scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy.</p>
A.C MAGALHAES et al	2007	110 bovine teeth	<p>Group 1: Duraphat D(NaF, 2.26% F, pH4.5)</p> <p>Group2: Duofluorid F(NaF, 2.71% F, pH8)</p> <p>Group3: TiF4 T (2.5%F, pH1.0)</p> <p>Group4: no fluoride P(pH5)</p>	<p>Duration: 7 days</p> <p>110 enamel blocks were prepared from bovine incisor tooth. These were allotted to the mentioned groups. A 6hour demineralization treatment was done followed by a 18hour remineralization treatment. These were then subjected to 7 days pH</p>

				cycles. Knoop microhardness test was performed.
Adflis Kalina Alexandria et al	2018	48 wistar rats	Group 1: TiF ₄ Varnish Group 2: Duraphat Group 3: Placebo varnish(No Fluoride) Group 4: No treatment	Duration: 14 days 48 wistar rats were infected <i>Streptococcus sobrinus</i> and divided into the mentioned group. After 4 weeks, they were fasted for 2 hours and later subjected to a cariogenic diet containing 56% sucrose. The total smooth surface caries were evacuated using Larsons modification of keys.

Figure 2 : Outcome Data As Reported In The Included Studies

Author	Year	Outcome	Result
ENRICO COSER BRIDI et al	2018	TiF ₄ pretreatment without any use of the adhesive system or the distance had higher hardness means compared to the rest of the groups. However the use of TiF ₄ with single bond adhesive showed higher means of hardness.	TiF ₄ showed higher hardness means at 25µm depth irrespective of the use of adhesive system or the depth of the intersurface (p < 0.0001). There was no significant change with groups receiving TiF ₄ pretreatment at 50µm, 75µm, 100µm (p= 0.1036).no significant difference was found between adhesive system (p=0.6299) or between distances (p= 0.7187).
PENG WANG et al	2017	Overall Group 2 containing 2% TiF ₄ showed higher potency of remineralisation compared to the other groups (P<0.05).	In MicroCT scan it was observed that compared to group 6, group 2(2% TiF ₄) had greater influence remineralisation depth. Similarly compared with group 2, group 4 had a negative coefficient which was interpreted as a demineralisation outcome. In SEM and XPS- group 1,3,4,5,6 showed inadequate cluster of particles to cover all the dentinal tubules. Group 2 on the other hand showed adequate covering to all the dentinal tubules.
A.C MAGALHAES et al	2008	Group 3 containing TiF ₄ showed the highest remineralisation capacity when compared with varnish containing NaF as the	Group 1,2,3 containing fluoride varnish showed improved remineralisation compared to the placebo(group 4) (p<0.005). Similarly compared to group 1 and group 2,

		fluoride component	group 3 showed the highest remineralisation potency(p=0.001)
Adílís Kalina Alexandria et al	2018	Group 1 containing TiF ₄ showed lesser white spot lesion and lesion depth when compared to group 2 containing NaF as the fluoride component.	In smooth surface caries and fissure caries, Group 1 and group 2 showed significant decrease caries reduction compared to the placebo group and the negative control. For smooth surface caries: (p>0.05) For fissure caries: (p<0.05). However in group 1 showed lower white spot lesion and lesion depth compared to group 2 (p<0.05).

Discussion:

The study which was done by Enrico Coser Bridi et al. showed how much potency TiF₄ has compared to the different adhesive system. The study involved four groups, group one containing titanium fluoride varnish and a single coat of adhesive (CLE), group 2 containing titanium fluoride and double adhesive coating and other groups containing only the adhesive system. These were applied of different cavities with different outer depth and observed. The result showed that TiF₄ with single coating of adhesive showed the highest remineralization potential.

The study by Peng Wang et al. showed at what percentage titanium fluoride has the highest potential for caries prevention and remineralization. They sectioned the tooth and divided into 6 groups containing 1-4% titanium fluoride respectively and the other groups containing NaF and DDW respectively. These groups were where subjected to conditions for caries formation. These were then examined under different scanning system and it was concluded that the varnish containing 2.5% TiF₄ showed the highest efficiency in caries prevention. The study explained the mechanism by which TiF₄ worked which was by evenly spreading and

covering the dentinal tubules which prevents penetration of bacteria thereby preventing caries formation.

The aim of the study done by A.C Magalhaes et al. was to show both remineralization and demineralization capacity of TiF₄ varnish by comparing it to other fluoride varnish. This study was conducted on bovine teeth where different varnish were used according to the groups. These were subjected to demineralisation and sent for a 7 day pH cycle. Micro hardness test were performed showed that NaF and TiF₄ had almost similar action of rehardening of the enamel however TiF₄ showed higher remineralisation efficiency. This study thus proves that not only fluoride but also titanium plays an important role in remineralisation due to its anticariogenic property.

Another study by Adílís Kalina Alexandria et al. it mainly emphasizes on caries prevention potential of TiF₄ compared to NaF. This was done by using wistar rats. The molar teeth of each rat infected with *Streptococcus sobrinus* were treated the groups containing titanium fluoride varnish and NaF varnish respectively, they were group containing a placebo and a negative control. After treating with the varnish these were then subjected to a high

cariogenic diet. Then result showed that TiF₄ had least amount of white spot lesion.

Thus with the above study we can prove that TiF₄ has higher caries prevention potential due to its remineralisation property. Its not only due to the effect of fluoride but also the strengthening property of Titanium that makes TiF₄ varnish a better compared to other varnish. Another study by Biatriz Martines Souza et al.[10] in which they did a study on 63 children over a span of one year to prove that TiF₄ varnish can be used in children to prevent caries in areas with high fluoride content .A study by Skartveit L¹, Gjerdet NR, Selvig KA.[8] compared TiF₄, sodium fluoride and tin fluoride to see which fluoride compound caused the maximum retention of fluoride to the dentin surface. This was done in a period of 30 days during which the root surface section of teeth were immersed in the different fluoride solutions. Fluoride concentration was measured and it was concluded that TiF₄ had the longest duration of fluoride on the tooth surface (up to 28 days). Hence this study proved the long lasting effect of use of TiF₄. Caries lesions can occur in different condition and activity. It is not always possible to detect which varnish to be used based on these diverse condition hence a study conducted by [Comar LP](#)[12] showed the effect of TiF₄ under diverse cariogenic activity in comparison with NaF varnish. NaF caused remineralisation in 2 out of the 4 studies whereas TiF₄ varnish proved effective in all the different cariogenic activity.

Hence these studies were able to show how TiF₄ varnish was effective as a caries prevention agent by inducing remineralisation of enamel and dentin

Conclusion:

All the articles taken for this systematic review proved the effectiveness of titanium fluoride varnish as a caries preventive agent. Titanium fluoride acts by remineralizing the dentin and preventing the entry of microorganisms into the dentinal tubules. However further studies must be conducted In order to prove its effectiveness or caries prevention also, more awareness on titanium fluoride varnish as a alternative for caries prevention .

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