EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 68, 1269:1276, APRIL, 2022
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
ORTHODONTICS, PEDIATRIC AND PREVENTIVE DENTISTRY
Submit Date : 07-02-2022 • Accept Date : 21-03-2022 • Available online: 30-03-2022 • DOI : 10.21608/edj.2022.120230.1973

THE LONGEVITY OF FLUORIDE RELEASE FROM TWO DIFFERENT FLUORIDE VARNISHES UNDER THE EFFECT OF DIODE LASER APPLICATION: AN IN VITRO STUDY

Yassmin Yasser Hammad*, Mohamed Sherif Mohamed Salah Eldeen Farag**
and Yousra Samir Mohamed Helmy***

ABSTRACT

Introduction: Fluoride has the ability to incorporate into the crystalline lattice of dental hard tissues, resulting in less solubility in acidic environment. The laser–fluoridation combination is a technique that combines the application of fluoride varnish along with laser. Aim of study: This study aimed to evaluate and compare the effect of diode laser when irradiated at diffirent powers and when used either before or after fluoride varnish application on the longevity of fluoride release using ion selective electrode, from three different fluoride varnishes (in vitro study): Enamel pro varnish and Clinpro XT varnish.

Material and Methods: 40 samples were collected, and then divided into 2 groups: Group I: Enamel pro and Group II: Clinpro XT. Each group was further subdivided into 5 subgroups, according to diode laser application, then samples were placed individually in a test tube containing artificial saliva. Fluoride release was measured by ion selective electrode for fluoride.

Results: Clinpro XT had the highest amount of fluoride release. There was a statistically significant difference in fluoride release when diode laser was irradiated at 7 Watt, after Enamel pro and Clinpro XT application.

Conclusion: Enamel pro and Clinpro XT can be used efficiently as fluoride varnishes. Diode laser irradiation at 7 Watt after fluoride varnish application has a profound effect on fluoride release.

KEYWORDS: Diode laser, varnishes, Fluoride release.

* Pediatric, Preventive Dentistry and Dental Public Health, Faculty of Dentistry, Suez Canal University.
** Professor and Chairman of Pediateric and Community Dentistry Suez Canal University
*** Assistant Professor, Pediatric Dentistry, preventive Dentistry and Dental Public Health, Faculty of Dentistry, Suez Canal University, Ismailia, Egypt

INTRODUCTION

Dental caries is a major health problem, despite all the efforts for the improvement of the dental health care over the past years. Dental caries is a dynamic process that involves cycles of demineralization and remineralization [1,2]. The use of fluoride for caries prevention has been known for many decades. The fact that fluoride can be incorporated in the enamel matrix, resulting in the formation of fluorhydroxyapatite that is less soluble in acidic environment, has been the scientific cornerstone for caries prevention. The success of topical fluoride treatment depends mainly on the formation of fluoride reservoirs on the tooth surface. These reservoirs are capable of supplying the tooth surface by fluoride ions for prolonged period of time [3]. One of the most commonly used fluoride varnishes is Enamel-Pro due to its ability to release fluoride for prolonged period of time [4]. In a study that was conducted to compare the amount and rate of fluoride release from Enamel Pro and vanish XT withVanish and Duraphat with one group was not treated and served as a negative control. The concentration of fluoride was measured in ppm, using ion selective electrode for fluoride. According to the results of this study, both Enamel Pro and Vanish XT had significantly higher fluoride release from Duraphat and Vanish [2] .

Former studies proved that glass ionomer-based fluoride varnishes (e.g., Clinpro XT) have exhibited sustained release of fluoride for extended periods of time, more than the conventional fluoride varnishes [5,6]. In a clinical trial, that was conducted to compare the efficacy of caries prevention of Clinpro XT Varnish, Multifluorid, Gluftored and a control group, in which the patients were given the recommendations on oral hygiene with the use of fluoride toothpaste. Prevention efficacy was determined using the test of enamel resistance (painting of enamel area pretreated with acid). They found out that the use of long-acting fluoride varnish Clinpro XT Varnish was statistically significant in increasing the enamel resistance when compared to the other fluoride agents [7]. In the last two decades, several studies evaluated the effect of laser–fluoridation technique which combines the application of fluoride varnish along with the application of laser on fluoride release and caries prevention. According to these studies, this technique improved fluoride binding to the enamel and increased the incorporation of fluoride into the hydroxyapatite structure, when combined with topical fluoride. This combination results in the formation of fluor-hydroxyapatite and calcium fluoride (CaF_2) on the enamel surface serving as a reservoir of fluoride [8,9]. In a systematic review, that was conducted to determine the efficacy of laser in caries prevention either when only laser was applied on the enamel surface or when used in combination with fluoride varnish, they found out that lasers can induce crystallographic changes on enamel, effectively increasing its acid resistance and significantly inhibiting caries development and progression through promoting changes in the shape and size of hydroxyapatite crystals and loss of prismatic structure, leading to formation of new crystalline phases, which are less resistant to demineralization. However, a combination of a laser and fluoride is the most promising treatment for caries prevention [10].

According to the available data, there is a relation between diode laser application and fluoride release when diode laser is applied either before or after fluoride varnish application. so, the present study was conducted to determine the effect of diode laser application when used at two diffirent laser power with standardized application time 15 seconds, either before or after fluoride varnish application on the longevity of fluoride release and add more data regarding fluoride release and laser-fluoridation from these fluoride varnishes in the pediatric dental field.

MATERIAL AND METHODS

The present study was conducted after the approval of the Research Ethics Committee of Faculty of Dentistry, Suez Canal University, on 9th of September 2018, code 126/2018, as no living subjects were at any risk during this study.

In this study, the following material were used;

1-Enamel Pro varnish, 5% Sodium fluoride and 2.3% Amorphous Calcium Phosphate (ACP), manufactured by Premier Dental Products Co., USA.

2-Clinpro XT varnish, Resin modified glass ionomer and 5% soduim fluoride, manufactured by 3M ESPE, Australlia.

Sample size calculation:

Fourty extracted upper and lower premolars, were calculated according to g power software virsion 3.1.9.6 with computed effect size (f) of 0.65, alpha (α) level of 5%, Beta (β) level of 20% and power of 0.80, these calculations weres based upon the results of **Virupaxi SG et al. 2016** [11].

Teeth Selection:

A total of 40 premolars, that was extracted for orthodontics purposes, were collected from Outpatient Clinic of Maxillofacial Department, Faculty of Dentistry, Suez Canal University. The extracted premolars were thoroughly cleaned using a fluoride free slurry pumice and a prophylaxis brush in a contra-angled low speed hand piece and then, stored in distilled water for one month until the day of experiment.

Samples grouping:

The 40 premolars were divided into two main groups according to the type of fluoride varnish used, each contained 20 premolars. Then each group

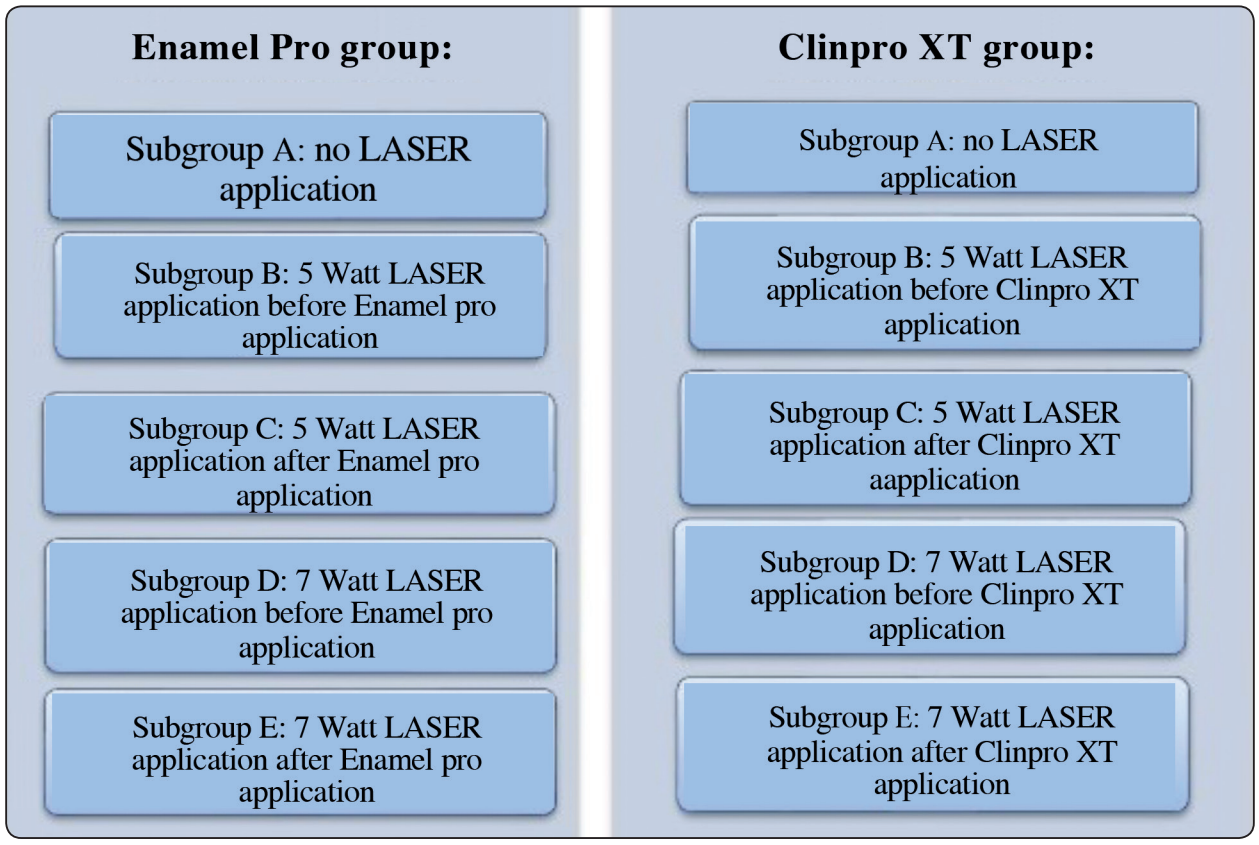

Fig. (1) : Sample grouping and laser treatment

was further subdivided into 5 subgroups according to laser apllication, each contained 4 premolars. Then each premolar was sectioned mesiodistally using a disc, after the removal of the roots to obtain two samples from each premolar, so that each subgroup contain 8 samples (fig.1). The distribution of premolars before sectioning was preformed to ensure that each subgroup contained equal number of buccal and lingual samples. After sectioning, all samples were covered by nail polish except a 4x4 mm window.

Laser treatment:

A commercial diode laser (epic x-Biolase) with a wavelength of 940 nm and a power up to 10 Watt was used in the present study. Two different powers of diode laser were used; 5Watt or 7Watt. The time of laser application for each sample was standardized in all subgroups at 15 continuous seconds.

Standardization of the distance between the sample and optic fiber of diode laser was performed using a putty model of 9x9 mm, in which the sample was placed to ensure equal distance between the tip of the laser hand piece and the enamel surface of the sample (fig.2). The laser tip was held perpendicularly to the samples with a tip/sample distance of 5 mm [9].

After fluoride varnish and diode laser application, each sample was placed in individual test tube at room temperature, containing 3ml of artificial saliva which was prepared in Inorganic Chemistry department at Faculty of Science, Suez Canal University. The artificial saliva composed of 1.5 mmol/L Cacl2, 50 mmol/L KcL, 0.9 mmol/L KH2Po4 and 20 mmol/L tris buffer at pH of 7.2 [12]. The artificial saliva was changed after after 1 day, 1 month, 3 months and 6 months from the application of fluoride varnishes [6].

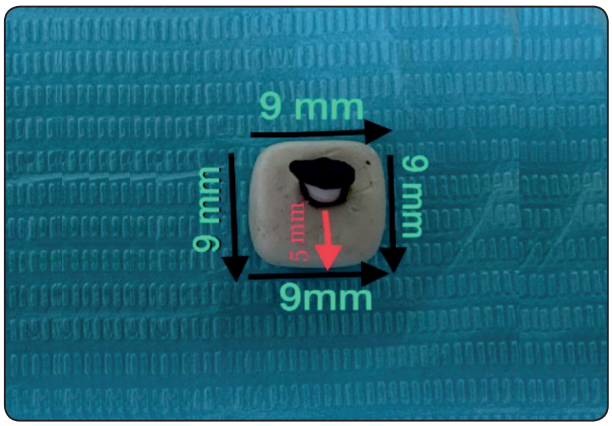

Fig. (2) : putty mold

Fluoride measurement [2]:

Fluoride ions leaching out into the artificial saliva was measured in parts per million (ppm) by ion selective electrode for fluoride at Faculty of Science, Ain Shams University. The samples were measured after treatment application at 1day, 1 month, 3 months and 6 months

RESULTS

The results of the present study showed that the Clinpro XT Varnish had consistently and substantially more fluoride release than Enamel Pro over an extended period of 6 months. Also, there was a statistically significant difference between the application of diode laser at 5 and 7 Watt and when applied either before or after fluoride varnish application.

Fluoride release in main groups:

In Enamel pro group the greatest mean of fluoride release was observed during the 1st day, 1st month, 3rd month and finally the 6th month. The highest mean of fluoride release was recorded i n subgroup E (fig 3).

In Clinpro XT group the greatest mean of fluoride release was observed during the 1st month, 3rd month, 6th monthand finally the first day.The highest mean of fluoride release was recorded in subgroup E (fig 4).

Fluoride release comparison in subgroups:

Fluoride release comparison in subgroups A:

There wa highly statically significant difference in fluoride release betweenthe the two subgroups at P-Value <0.001(fig 5)

Fluoride release comparison in subgroups B and C

There was a statically significant difference between diode laser application before and after fluoride varnish application as P-Value <0.05 (fig 6)

Fluoride release comparison in subgroups D and E:

There was a highly statically significant difference between diode laser application before and after fluoride varnish application as P-Value <0.001 (fig 7)

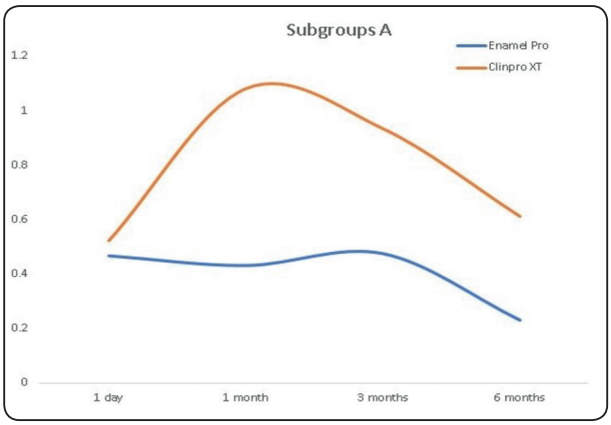

Fig. (5) Fluoride mean release in ppm in subgroups A.

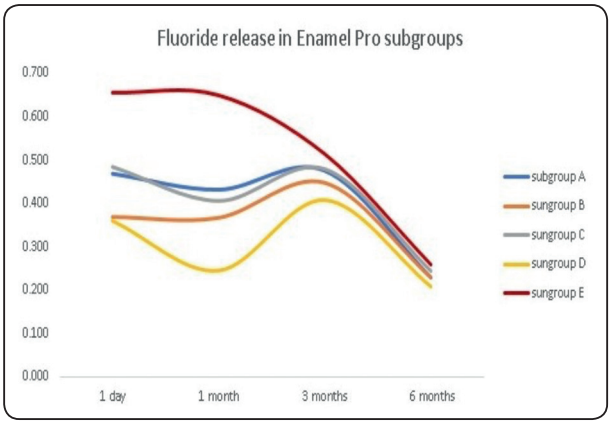

Fig. (3) Fluoride mean release in ppm in Enamel Pro subgroups.

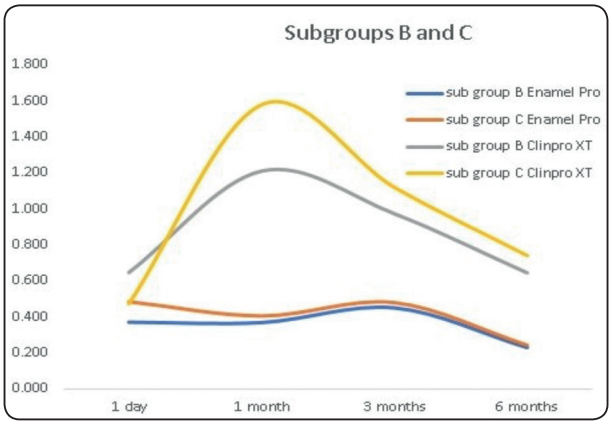

Fig. (6) fluoride mean release in ppm in subgroups B and C.

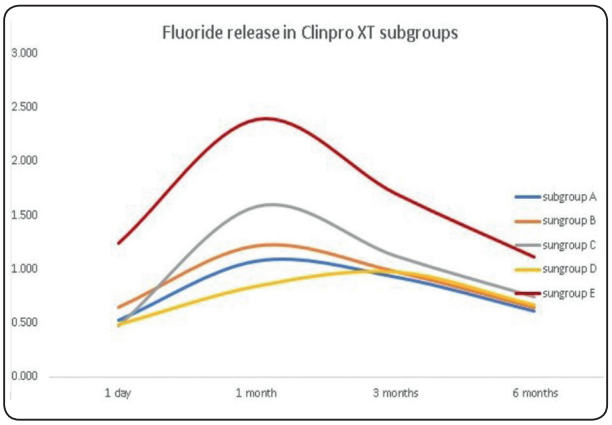

Fig. (4) Fluoride mean release in ppm in Clinpro XT subgroups.

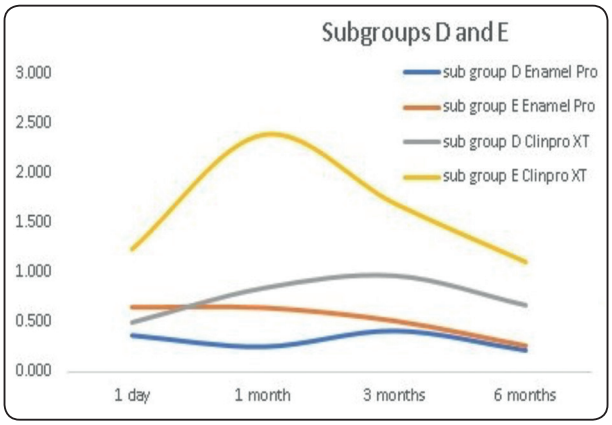

Fig. (7) fluoride mean release in ppm in subgroups D and E.

DISCUSSION

In this study, the benefits of combining fluoride varnish application with diode laser irradiation on fluoride release were evaluated when diode laser irradiation was utilized either before or after fluoride varnish application. According to the findings of this investigation, all the fluoride varnishes release fluoride but the rate of fluoride release is not constant, it varies. This is probably because of varied additives in each fluoride varnish's formulation, which affects the rate of release of fluoride between the three fluoride varnishes. According to the findings of this study, there was a statistically significant difference in the fluoride mean release of the Enamel Pro group over the course of six months, with the maximum fluoride release observed at one day, followed by three months, one month, and finally six months.

This could be related to its composition, which contains 5% sodium fluoride and 2.3 percent ACP. Sodium fluoride released fluoride at the first day, then interacted with tooth structure to generate fluoridated apatite (firmly bound) or calcium fluoride (loosely-bound). The fluoride is firmly bonded and integrated onto the surface of the apatite crystals. While the weakly bound fluoride worked as a reservoir source, it delivered a rather slow release of fluoride. Meanwhile, calcium and phosphate were released by the ACP. Because the calcium released was bound with fluoride, the presence of calcium fluoride increased, resulting in an increase in fluoride mean release in the third month [(4)]. Similar results to our study was found by Jablonowski et al., 2012 [(1)], where he saw that enamel pro showed high fluoride release when compared to Vanish XT, Vanish, and Duraphat. The findings of this research, on the other hand, are in contrast to those of **Cochrane et al., 2014** [(13)], who evaluated fluoride, calcium, and inorganic phosphate ions released from five different fluoride varnishes: MI varnish, Clinpro white,Enamel Pro varnish, Biflourid, and Duraphat, and reported that Enamel Pro did not show substantially adequate fluoride release.In our study Clinpro XT varnish released consistently and substantially more fluoride than nml Pro in the period of 6 months. This is probably due to the chemical bond between glass ionomer of Clinpro XT varnish and tooth structure. Based on resin modified glass ionomer technology, fluoride release would be slower and extended . The results of this in-vitro study indicated that the Clinpro XT Varnish had th highst mn of fluori rls whn ompr to th othr groups. The highest fluoride release was recorded at one month, three months, six months, and one day. Clinpro XT varnish released a significant amount of fluoride over a 6-month period. This is probably due to the chemical bond between glass ionomer of Clinpro XT varnish and tooth structure. Based on resin modified glass ionomer technology, fluoride release would be slower and extended [(14)]. The results from this study, regarding fluoride release of Clinpro XT, are consistent with the conclusion of **Virupaxi, et al.,2016** [(11)], who stated that Clinpro XT had the highest fluoride mean release when compared to conventional fluoride varnishes, after evaluating the longevity of fluoride release from Clinpro XT, Flouritop SR and Flourprotector over a period of 6 months through salivary fluoride estimation, after 1 week, 1 month, 3 months and 6 months from varnishes application.The current study's findings, on the other hand, differ from those of **Scotti et al., 2019** [(15)], who investigated the effect of Clinpro XT and Duraphat varnishes on inhibiting demineralization of underlying and adjacent areas surrounding caries-like lesions in enamel and measuring fluoride release.

By the end of their study, they concluded that there was no statistically significant difference in the percentage of fluoride release among the three groups; this difference in conclusion could be attributed to the fact that they measured fluoride release in demineralized tooth structure, rather than sound tooth structure, as in the current study.. According to the results of this study there was a statistically significant difference between the use of diode laser either before or after fluoride varnish application and regarding the power used, when

compared to no diode laser irradiation, this is may be attributed to heat generated from diode laser which in returns, aids the incorporation of fluoride into the hydroxyapatite structure and results in the formation of fluorohydroxyapatite and calcium fluoride (CaF2) on the enamel surface serving as a reservoir for fluoride.

Meanwhile, the diode laser irradiation was not that effective when used before fluoride varnish application as when it was used after fluoride varnish application because it did not have an effect on sound enamel as the atomic bond between the hydroxyapatite is stable and closed [16,17]. The results of the current study regarding the use of diode laser application were in agreement with **Moreno et.al., 2007** [8], who used diode laser at both 5, 7 and 10 Watt irradiation for 30 seconds in combination with Duraphat fluoride varnish. laser -fluoridation lead to increase in the fluoride uptake in general however, they stated that there was no statistically significant difference between different laser groups. Also, there was an agreement with the results from a study by **Al Maliky et al.,2019** [18], who concluded that the application of diode laser alone or after fluoride varnish application is useful for caries prevention more than fluoride varnish application alone, after assessing the effectiveness of 425 nm diode laser when used alone or when applied after topical fluoride varnish in inhabiting artificial caries lesions formation. On the otherhand, the results of the present study are not similar to the results of a study by **Santaella et al., 2004** [19], who evaluated caries prevention in primary teeth using only Duraphat 5% fluoride varnish or diode laser application for 1 min followed by, fluoride varnish application. According to their results, topical fluoride was more effective than diode laser in caries prevention. This may be attributed to the difference between the wave length of diode laser used in this study (699 nm) while the wave length used in the present study was (960 nm). There is also a disagreement with the results of **Bahrololoomi and Lotfian, 2015** [20], who evaluated the potentials of 5 and 7 Watt diode laser application for 30 seconds after Topex DuraShield (5% NaF) fluoride varnish application in remineralization of artificial caries. the combined application of diode laser and topical fluoride varnish on enamel surface did not show any significant effect on enamel resistance to caries.

CONCLUSIONS

Both Clinpro XT and Enamel pro can be used effectively bi-annually, as they both have extended fluoride release over the period of six months.

Diode laser application after fluoride varnish applicant had an effect in increasing fluoride release meanwhile diode laser application before fluoride varnish application did not have a significant effect on fluoride release.

The use of 7 Watt diode laser is more effective than the use of 5 Watt.

Limitations

There are limitations to using the data from our study directly in clinical practice. This in-vitro study measured the rate of fluoride release using artificial saliva, the dynamics of human saliva affecting the rate of fluoride release were not considered. However, the data from this in-vitro study provides the clinician the knowledge of fluoride varnishes which releases fluoride over extended time period so that the selection of varnish can be made based on each individual patient clinical presentation and provider preference.

Recommendation

1- Further in vitro studies are need to compare the effect of diode laser application at different powers on fluoride release, remineralization and to evaluate its effect on pulpal temperature.

2- Further in vivo studies are need to assess the longevity of fluoride release from Enamel pro and Clinpro XT and also assess their effect on demineralized tooth structure.

REFERENCES

1. Gao SS, Zhang S, Mei ML, Lo EC, Chu CH. Caries remineralisation and arresting effect in children by professionally applied fluoride treatment–a systematic review. BMC oral health. 2016; 16:1-9.
2. Jablonowski BL, Bartoloni JA, Hensley DM, Vandewalle KS. Fluoride release from newly marketed fluoride varnishes. Quintessence International. 2012 ;43- 46.
3. Clarkson JJ, McLoughlin J. Role of fluoride in oral health promotion. International dental journal. 2000; 50(3): 119-28.
4. Goodchild J., DMD Prophy Paste Enamel Pro ADA Dental Product Guide. ADA DENTAL PRODUCT GUIDE 2017 VOL.6 (5). Found at https://www.premierdentalco.com/wp-content/uploads/2015/01/ADA-Dental-Product-Guide-2018.Vol-6.Issue-5-EPPP.pdf
5. Wang Y, Mei L, Gong L, Li J, He S, Ji Y, Sun W. Remineralization of early enamel caries lesions using different bioactive elements containing toothpastes: An in vitro study. Techno Health Care. 2016; 24: 701-711.
6. Kumar K, Sreedharan S. Comparative evaluation of the remineralization potential of monofluorophosphate, casein phosphopeptide-amorphous calcium phosphate and calcium sodium phosphosilicate on demineralized enamel lesions: An in vitro study. Cureus. 2018; 7: 10-17.
7. Silin AV, Satygo EA. Efficacy of the caries preventive agents in children during mixed dentition period. Stomatologiia. 2014 ;93(4):58-60.
8. Villalba-Moreno J, González-Rodríguez A, de Dios López-González J, Bolaños-Carmona MV, Pedraza-Muriel V. Increased fluoride uptake in human dental specimens treated with diode laser. Lasers in medical science. 2007; 22(3):137-42.
9. Malmström HS, McCormack SM, Fried D, Featherstone JD. Effect of CO2 laser on pulpal temperature and surface morphology: an in vitro study. J. Dent. 2001; 29: 521-529.
10. Ana PA, Bachmann L, Zezell DM. Lasers effects on enamel for caries prevention. Laser physics. 2006; 16(5):865-75.
11. Virupaxi SG, Roshan NM, Poornima P, Nagaveni NB, Neena IE, Bharath KP. Comparative evaluation of longevity of fluoride release from three different fluoride varnishes–an invitro study. Journal of clinical and diagnostic research: JCDR. 2016 ;10(8): 33-38.
12. Agnihotri Y, Pragada NL, Patri G, Thajuraj PK. The Effect of CPP-ACP on Remineralization of Artificial Caries like lesions: An Invitro study. Indian Journal of Multidisciplinary Dentistry. 2012; 2(1) :366-369.
13. Cochrane NJ, Shen P, Yuan Y, Reynolds EC. Ion release from calcium and fluoride containing dental varnishes. Australian Dent J. 201;59(1): 100-5.
14. Sakaguchi RL, Powers JM. Craig's restorative dental materials-e-book. Elsevier Health Sciences; 2012.
15. Scotti CK, Velo MM, Brondino NC, Guimarães BM, Furuse AY, Mondelli RF, Bombonatti JF. Effect of a resin-modified glass-ionomer with calcium on enamel demineralization inhibition: an in vitro study. Braz. Oral Res. 2019;33: 15-26.
16. Zhang D, Tamilselvan A. Lattice energy and mechanical stiffness of hydroxyapatite. Journal of Materials Science: Materials in Medicine. 2007 ;18(1):79-87.
17. Parker SP. Laser–tissue interaction. In Lasers in Dentistry—Current Concepts 2017 (pp. 29-55). Springer, Cham.
18. Al-Maliky MA, Frentzen M, Meister J. Artificial caries resistance in enamel after topical fluoride treatment and 445 nm laser irradiation. Biomed Res Int. 2019;2019; 31-35.
19. Santaella MR, Braun A, Matson E, Frentzen M. Effect of diode laser and fluoride varnish on initial surface demineralization of primary dentition enamel: an in vitro study. Int. J. Paediatr. Dent.2004;14: 199-203.
20. Bahrololoomi Z, Lotfian M. Effect of diode laser irradiation combined with topical fluoride on enamel microhardness of primary teeth. J. Dent (Tehran, Iran). 2015; 12:85-89.