



## AN INVESTIGATIVE STUDY ON ROLE OF LASERS IN REMINERALIZATION AND CARIES PREVENTION

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### ABSTRACT

Fluoride is a mineral that occurs naturally in many foods and water. Every day, minerals are added to and lost from a tooth's enamel layer through two processes, demineralization and remineralization. Minerals are lost (demineralization) from a tooth's enamel layer when acids-formed from plaque bacteria and sugars in the mouth -attack the enamel. Minerals such as fluoride, calcium, and phosphate are redeposited (remineralization) to the enamel layer from the foods and waters consumed. Too much demineralization without enough remineralization to repair the enamel layer leads to tooth decay. Fluoride helps prevent tooth decay by making the tooth more resistant to acid attacks from plaque bacteria and sugars in the mouth. It also reverses early decay. In children under 6 years of age, fluoride becomes incorporated into the development of permanent teeth, making it difficult for acids to demineralize the teeth. Fluoride also helps speed remineralization as well as disrupts acid production in already erupted teeth of both children and adults. The aim of the present study was to compare the effect of CO<sub>2</sub> laser; fluoride varnish; and CO<sub>2</sub> laser and fluoride varnish on initial surface demineralization of permanent dentition enamel. Thereby, to assess the caries preventive potential of CO<sub>2</sub> laser treatment of enamel compared to topical fluoride application.

**KEYWORDS:** Dental Caries, Fluoride Application, Dental Lasers, CO<sub>2</sub> Laser, Prevention, Pit & Fissure Sealants.

### INTRODUCTION

In spite of the decline observed in dental caries, it still represents the most prevalent chronic childhood oral disease. Caries is a dynamic process, fluctuating between demineralization and remineralization process, beginning with the microscopic loss of crystal structure progressing to complete destruction and cavitation. In the past, fluoride and fissure sealants were the primary caries preventive agents. Fluoride has been proven to be an effective treatment for the prevention of dental caries by inhibiting demineralization and enhancing remineralization. Of all the new avenues open to caries prevention through increased acid resistance, the use of laser in the prevention of demineralization is one of the most fascinating and promising of all. The use of laser irradiation as a means of inhibiting dental caries was first suggested by Stern and Sognnaes<sup>[1-12]</sup>. Laser treatment is effective in elevating the resistance of enamel to cariogenic challenge by changing the surface structure and physical properties, including melting and recrystallization of the enamel hydroxyapatite crystals. Several investigators have demonstrated that treatment with various lasers such as the CO<sub>2</sub>, Nd: YAG and Argon lasers can reduce the subsurface demineralization rate in enamel. CO<sub>2</sub> laser appears to be the most efficient in this regard due to the enamel absorption coefficient which closely corresponds to the CO<sub>2</sub> laser emission wavelength. The efficacy of CO<sub>2</sub> laser irradiation combined with fluoride in inhibiting enamel demineralization has been demonstrated in several laboratory investigations<sup>[12-18]</sup>.

### MATERIALS AND METHODS

**Experimental Group 1 (fluoride):** Enamel was treated with fluoride varnish (Fluor Protector®) for 5 minutes.

**Experimental Group 2 (laser):** Enamel was irradiated with laser (Waterlase® iPlus™) for 20 seconds.

**Experimental Group 3 (laser with fluoride):** Laser irradiation (Waterlase® iPlus™) for 10 seconds followed by fluoride varnish over a period of 5 minutes.

Laser etching was done for 10 sec using Er, Cr:YSGG laser (Waterlase® iPlus™) in noncontact mode, at a distance of 15mm with pulse duration of 140µs at 4W energy (60% water 40% air), 50 Hz energy. After treating the teeth with their respective group reagents the teeth were immersed in artificial saliva and the solution was changed every day.

#### Artificial saliva

- 0.222g/L gastric mucin
- 0.381g/L Sodium chloride
- 0.213g/L Calcium chloride
- 0.738g/L Potassium hydrogen phosphate
- 1.114g/L Potassium chloride.

After 3 cycles of Remineralization teeth were sectioned to a thickness of 0.5mm using carborundum disk and each section obtained was visualized under polarized light microscope and statistical analysis was done.

### RESULT

One sample was studied from each group to observe the demineralization (figure-1).

Fluoride ions are involved in three principle reactions of remineralization:

LAFI comparison of different wavelengths

1. Iso-ionic exchange of  $F^-$  for  $OH^-$  in apatite:  
 $Ca_{10}(PO_4)_6(OH)_2 + 2F^- \rightarrow Ca_{10}(PO_4)_6F_2 + 2OH^-$   
 2. Crystal growth of fluorapatite from a supersaturated solution:  
 $10Ca^{2+} + 6PO_4^{3-} + 2F^- \rightarrow Ca_{10}(PO_4)_6F_2$

3. Apatite dissolution with  $CaF_2$  formation:  
 $Ca_{10}(PO_4)_6(OH)_2 + 20F^- \rightarrow 10CaF_2 + 6PO_4^{3-} + 2OH^-$

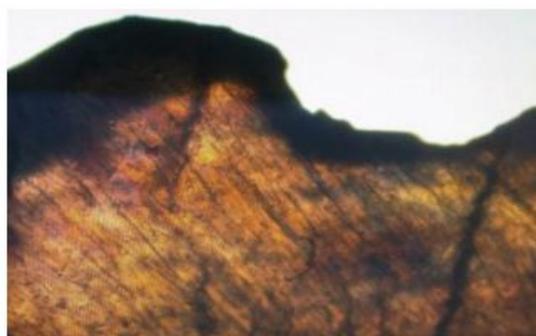


**FIGURE 1:** shows the area of demineralization after removing the teeth from demineralizing solution

Area of demineralization after immersing the teeth in demineralizing solution. Black band in the image represents the area of demineralization. The black zone indicates the areas of demineralization in this image.

**Experimental Group 1 (fluoride)**

Remineralization observed after fluoride varnish (Fluor Protector®) application. Reduction seen in area of demineralization, there is reduction in the thickness of black zone which is the demineralized zone as compared to that of first image (figure-2).

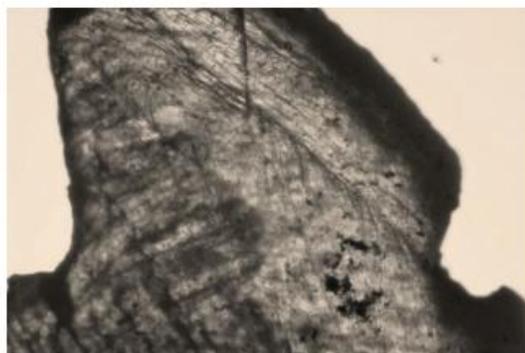


**FIGURE 2:** there is reduction in the demineralized zone since a part of the lesion is remineralized after fluoride varnish (Fluor Protector®) application

**Experimental Group 2 (laser)**

Reduction in demineralized area after Laser treatment (Waterlase® iPlus™). Drastic decrease in the reduction in

black band which shows that the lesion has remineralized to a greater extent as compared to that of previous picture (figure-3).

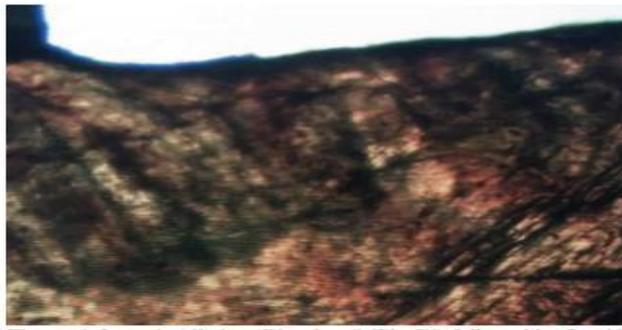


**FIGURE 3:** drastic reduction in the demineralized area after laser (Waterlase® iPlus™) irradiation for 20 seconds)

**Experimental Group 3 (laser with fluoride):**

Reduction in demineralized area after treating with Laser and fluoride varnish. Disappearance of the black

demineralized clearly shows that near total Remineralization of the demineralized zone has been achieved by the lesion (figure-4).



**FIGURE 4:** the demineralized area has almost disappeared since almost the entire lesion has been remineralized after laser irradiation followed by fluoride varnish application

## DISCUSSION

The fluoride concentration and pH of topical fluoride solution have an influence of fluoride uptake into enamel. It works by replacing the hydroxyapatite crystals of tooth into more resistant fluorapatite crystals hence reducing the enamel surface dissolution ability. Laser pretreatment of enamel can be opted as an alternative to fluoride application, which incorporate subsequent acid-induced dissolution of enamel. The implication of Laser irradiation as a means of inhibiting dental caries was first suggested by Stern and Sognaes<sup>[19-22]</sup>. Recent studies show that hard tissue applications limit the polymerization of visible light, cure preventive and restorative materials, cavity preparations for restoration placement and tooth whitening procedures as well as include the laser applications for caries prevention and dentin hypersensitivity. It has been reported that lasers improve enamel's resistance to dissolution, enhance microhardness, and lessen *in vitro* caries formation and progression. Laser irradiation use to prevent dental caries depends on physical, chemical and crystalline changes which are induced in enamel because of heating of the surface<sup>[23-25]</sup>. The change that takes place in the crystalline structure is that the hydroxyapatite crystals of enamel get replaced by a very resistant pyrophosphate crystal upon laser irradiation. The cause of re-mineralization has been High energy laser irradiation of enamel alone at a specified wavelength. Also, one theory states that, laser irradiation decreases enamel permeability because of physical fusion of enamel surface microstructure. On the other hand, one theory focused on a combination of reduced enamel permeability with reduction in solubility by melting, fusion and recrystallization of enamel crystallites, that helps in sealing the surface of the enamel. Moreover, reduction in enamel solubility possibly be due to ultra-structural changes in enamel crystallography. Reduction of water and carbonate contents, formation of pyrophosphates, and decomposition of proteins have been found. Fowler and Kuroda<sup>7</sup> elaborated the need of a temperature from 1000 C to 6500 C to promote the photo thermal effects that helps in increasing the acid resistance of enamel. Whereas, certain questions come up like whether the increase in temperature can affect the surrounding tissues and could increase the possibility of pulp damage. Due to this, water cooling was used during the laser irradiation in this study.

## CONCLUSION

The results of this *in vitro* studies have shown that, among the three groups i.e. one with fluoride varnish application, one with laser irradiation alone and one with laser irradiation followed by fluoride varnish application, the last group had shown the most effective & convincing results leading to better clinical prognosis. The combined application of the laser and fluoride varnish shows a better treatment modality for the health Remineralization

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