

# EVALUATION OF 4% TITANIUM TETRAFLUORIDE IRRIGATION ON THE SEALING ABILITY OF THE MODIFIED SMEAR LAYER TO THE DENTINAL TUBULES- IN VITRO STUDY

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## ABSTRACT

The objective of this study was to modify smear layer so that it bonds to the dentinal wall and seals the dentinal tubules. Thus the aim of the study was to evaluate the sealing ability of 4% Titanium Fluoride modified smear layer to the root canal wall using SEM. Twenty extracted human maxillary central incisors were used, standard access cavities were prepared and cleaning and shaping was carried out till 60 size K File. The samples were divided into two groups Group A experimental group and Group B control group with ten samples in each. In experimental group final irrigation was carried out with freshly prepared 4% TiF<sub>4</sub> and control group samples were left untreated. The samples were then sectioned into halves and examined under SEM for thickness of smear layer and length of smear plug formation. The data obtained was statistically analyzed by Tukey T test. Results obtained showed that there is increased thickness of smear layer formation of about 5.68-8.18µm which strongly adheres to root canal walls and the depth of smear plug ranged from 18.8-38.8µm. To conclude it is strongly recommend using 4% TiF<sub>4</sub> as final rinse for 1 min before obturating the root canals.

## INTRODUCTION

The success of root canal therapy depends upon the knowledge of root canal anatomy, the method and quality of instrumentation, the type of irrigant used and the three dimensional obturation of the root canal.<sup>7</sup> During instrumentation a superficial layer of about 1 to 2 µm thickness and penetration depth of 40 µm in the dentinal tubule is formed<sup>11</sup>. This layer which consists of inorganic dentinal tissue and organic pulpal tissue along with microorganisms is termed as smear layer<sup>8</sup>. Due to its loose bounding nature and permeability to bacteria along with its dissolving nature, it has been an issue of controversy over its presences in the root canal during obturation<sup>4, 12</sup>.

Its presences act as a natural barrier and its removal leads to bacterial invasion of the dentinal tubules in case the apical seal fails<sup>1, 4</sup>. Were as its presence on the root canal wall acts as an immediate physical barrier and interfere with the adhesion and penetration of the root canal sealer<sup>5, 6, 16, 22</sup>.

Today it is believed that instead of completely removing the smear layer, modifying it is beneficial. Many materials have been used for this purpose. Recently, the use of 30% potassium oxalate and 4% Titanium fluoride has been put forward for this purpose<sup>2, 11</sup>.

In this study we hypothesize that the use of 4% Titanium Fluoride modifies the smear layer and increases its sealing ability. So the aim was to evaluate the sealing ability of 4% Titanium Fluoride modified smear layer to the root canal wall using SEM.

## MATERIALS AND METHOD

Twenty extracted maxillary central incisors were used in the study. Teeth were extracted from healthy patients who were advised extraction due to prosthetic and periodontal reasons. The samples were stored in formalin till further use. Access opening was made using a No.4 carbide round bur. Working length was established 1mm short of the apex and cleaning and shaping was carried out till 60 size K file following standard endodontic technique as described by Grossman. The samples

were then divided into two groups. Group A experimental group with a sample strength of 10 and Group B control group with 10 samples. For Group A 4% titanium fluoride (TiF<sub>4</sub>) was freshly prepared by dissolving 3.4 gms of TiF<sub>4</sub> in 100 ml of demonized distill water. And irrigation was carried out in all the 10 samples for group B samples were left unirrigated to serve as control.

All the teeth were grooved longitudinally on the facial and palatal surfaces, with a safe sided diamond disc and later were split half carefully using a chisel and mallet. The specimens prepared on the safe side of disc were used for the study. All the selected specimens were dehydrated by using ascending grades of ethanol. The specimens were then vacuum dried and were sputter coated with gold for examination under SEM.

The samples were photographed under SEM and thickness of smear layer was measured at three different levels i.e. minimum, intermediate and maximum using computer software. Length of smear plug inside the dentinal tubule was measured and statistical analysis was carried out using tukey t test. Results

**Table 1:** Smear layer thickness

Groups	Experimental Group (Thickness in $\mu\text{m}$ )	Control group (Thickness in $\mu\text{m}$ )
Mean values	7.17±0.45	2.08±0.20

Table value of t=2.101 at p=0.05

**Table 2:** Length of Smear plug

Groups	Experimental Group (length in $\mu\text{m}$ )	Control Group (length in $\mu\text{m}$ )
Range Of Plug	18.8-38.8	10.5-21.7

Average of the thickness of the smear layer in the experimental group was found out to be 7.17±0.45  $\mu\text{m}$ , were as in the control group the average thickness was 2.08±0.20  $\mu\text{m}$ . The data obtained reviled that the thickness of smear layer increases with the use of 4% TiF<sub>4</sub> for 1 min.

**DISCUSSION**

An important determinant of the success or failure of conventional endodontic therapy is the presence or absence of microleakage at the

obturating material and the canal wall interface. The deterrent present between them is smear layer<sup>3, 7, 12, 14</sup>. Smear layer is a nonhomogeneous, non adherent, granular structure which is formed during instrumentation<sup>3</sup>. It is typically 1-2 $\mu\text{m}$  thick and penetrates the dentinal tubules to a depth of 7-40  $\mu\text{m}$ <sup>8</sup>.

Smear layer acts as a natural barrier to bacteria and bacterial products to entre from root canal into the dentinal tubules<sup>4</sup>. A success rate of 95% has been achieved in endodontic treatments without the removal of smear layer<sup>3</sup>. Also removal of smear layer has also been advocated by few others owing to its loose binding nature and solubility by bacteria<sup>12</sup>. But it is practically not possible to remove the smear layer completely due to the anatomical complexity of the root canal. Different materials like citric acid and potassium oxalate has been used without much success<sup>11, 13</sup>.

Today the concept has shifted to modify smear layer instead of removing it or leaving it as it is. Material like TiF<sub>4</sub> forms tenacious titanium rich coating on Enamel/Dentin/Cemental surface after a brief application period and this coating is stable and acid resistat<sup>10, 15, 17, 18, 21</sup>. This makes titanium fluoride a favorable material for modifying smear layer.

The photomicrographs of the study samples reveled that there is massive thick layer of titanium dioxide on the root canal walls occluding the dentinal tubules along with a modified smear layer and smear plugs in the dentinal tubules. This can be explained by the fact that titanium is a polyvalent metal ion that has an inorganic complex binding ability which forms a tenacious TiO<sub>2</sub> rich coating following the treatment with TiF<sub>4</sub> on the tooth structure<sup>2, 10, 18, 19, 20</sup>. In the root canal walls bonding is carried in between hydroxyapatite or the sealers used and titanium due to its high affinity toward the oxygen atom present in the tubular structure or the oxide, carbonate, sulfate and borate groups of the sealers commonly used<sup>9, 19</sup>.

Present study also revel an increase in the depth of penetration of the modified smear plug to about 18.8 - 38.8  $\mu\text{m}$ . were as in the control group the depth of penetration ranged from 10.5 – 21.7  $\mu\text{m}$  only. This increase in the depth of

penetration is well explained as when  $TiF_4$  is mixed with distilled water it reacts to form Hydrofluoric acid. This acid formed results in etching of the dentinal tubules leading to increase in the penetration of the smear plugs<sup>18</sup>.

Thus within the confirms of this study it can be conclude that 4%  $TiF_4$  when used as an irrigant modifies the smear layer to a composite and resistant structure that occludes the dentinal tubules to deeper depth. This study strongly recommends the use of 4%  $TiF_4$  as an irrigant before obturating the root canals.

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