# Effect of various chemical agents used in gingival retraction systems on smear layer: Scanning electron microscope study

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## Abstract

**Background:** Chemical agents used for gingival retraction affects the smear layer. **Aim:** To determine the effect of three different chemical agents used for gingival retraction systems on smear layer. **Materials and Methods:** Four human premolars were prepared using air-rotor with air-water spray to receive full crown restoration. Three of them were treated with 21.3% aluminum chloride for 10 min, 0.05% oxymetazoline hydrochloride for 10 min, and expasyl for 2 min, respectively. One sample was left untreated. Then, the tooth specimens were rinsed with tap water to remove any residue of test materials. All the samples (treated and untreated) were processed by scanning electron microscope (SEM). Processed samples were examined under SEM at ×2400 to evaluate the effect of chemical agents on smear layer. **Results:** SEM examination revealed that 0.05% oxymetazoline hydrochloride for 10 min produced no alteration to smear layer followed by minimum alteration by expasyl for 2 min and complete removal of smear layer with etching of dentin with 21.3% aluminum chloride for 10 min. **Conclusion:** 0.05% oxymetazoline hydrochloride and expasyl are kind to smear layer.

**Keywords:** Aluminum chloride, displacement, expasyl, gingival retraction, oxymetazoline hydrochloride, smear layer

## Introduction

Chemico-mechanical means of gingival retraction is a routine clinical procedure in fixed prosthodontics not only before impression making but also for finishing of intracrevicular margins and cementation of such restorations.[1-3] Until date, numerous chemical agents had been used for gingival retraction such as epinephrine, aluminum chloride, and ferric sulfate which are either vasoconstrictors or astringents.[4] Impregnating the cord with hemostatic solution just before its use had been recommended.[2,3] In intracrevicular margins, these hemostatic solutions will invariably come in direct contact with tooth structure.

The effect of different chemical agents on smear layer is variable. The clinician is always in a dilemma to choose which hemostatic solution on the basis of its effect on smear layer. Even, relationship between thicknesses of smear layer with pH of the hemostatic solution should be established. The chemicals used in this study are routine hemostatic agents used for gingival retraction.

This study was planned to evaluate the effect of 21.3% aluminum chloride, 0.05% oxymetazoline hydrochloride, and expasyl paste on smear layer.

## Materials and Methods

The study protocol consisted of:

- Determination of pH of three different gingival retraction systems
- Preparation of tooth specimens for scanning electron microscope (SEM) examination
- Processing of specimens for SEM examination.

### Determination of pH of three different chemical agents

pH of 21.3% aluminum chloride, 0.05% oxymetazoline hydrochloride, and expasyl were determined using pH meter.

### Preparation of tooth specimens for scanning electron microscope examination

Caries free and periodontally sound human premolars extracted for purpose of orthodontic treatment were used

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for preparing specimens for SEM examination. The tooth was longitudinally sectioned into two equal halves, and then the root portion of the teeth was removed to increase accessibility. Teeth were prepared using air-rotor with air-water spray to receive full crown restoration [Figure 1]. One sample was left untreated for control group. The remaining prepared teeth were treated with respective groups.

- Group A - 21.3% aluminum chloride for 10 min
- Group B - 0.05% oxymetazoline hydrochloride for 10 min
- Group C - expasyl paste for 2 min.

The samples for Groups A and B were immersed in respective solutions for 10 min whereas expasyl was applied on the sample for Group C using applicator for 2 min.

Then, the tooth specimens were rinsed with tap water to remove any residue of test materials.

### Processing of specimens for scanning electron microscopic examination

Immediately after rinsing with tap water, treated specimens were fixed in 2.5% glutaraldehyde for 12 h at 4°C. After fixation, the specimen were washed with phosphate buffer solution and then dehydrated in ascending grades of alcohol (50%, 70%, 90%, and 100%) for 10 min each at room temperature. After the specimens were air dried, they were mounted on aluminum stubs with Araldite and silver paste which is used as a conducting medium as specimen is nonconducting. The specimens were sputter coated with gold-palladium (150–200 A° thick) using Polaron ES 2000, SEM auto coating unit. Analysis using a Cambridge Steroscan 250 MK III SEM operated between 10 and 20 KV was done at working distance of 6–8 mm. Each specimen surface was scanned in its entire to obtain on overview of the general surface topography. Areas characteristics of the general surface topography were selected and photographed.

## Observations and Results

### Determination of pH

pH of all the three groups was determined by using pH meter. pH of the tested group were as follows:

- Group A - 21.3% aluminum chloride - 1.82
- Group B - 0.05% oxymetazoline hydrochloride - 6.44
- Group C - expasyl paste - 3.86.

### Scanning electron microscopic examination

Representative samples of untreated and all the three treated groups were examined under SEM at ×2400 to evaluate the effect of three different gingival retraction chemical agents on smear layer.

In the untreated sample, an amorphous mass of debris was seen. The outlines of the tubular pattern of dentinal tubules were not visible. The debris was coagulated in certain areas [Figure 2].

In Group A, i.e., 21.3% aluminum chloride treated samples, dentinal tubules were wide open. Tubular pattern was clearly seen with etching of intertubular dentin. Some of the dentinal tubules were partially occluded indicating complete removal of smear layer with opened dentinal tubules and visible etching of dentin [Figure 3].

In Group B, i.e., 0.05% oxymetazoline hydrochloride treated samples, amorphous mass of debris was seen. Tubular

**Figure 1:** Samples prepared for scanning electron microscope examination

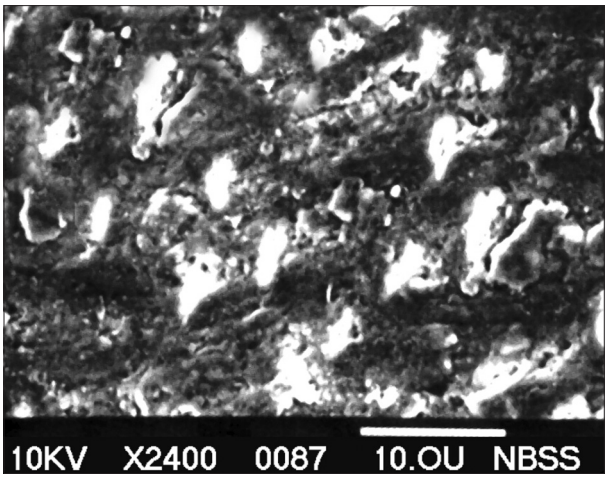


**Figure 2:** Scanning electron microscope photograph of control group

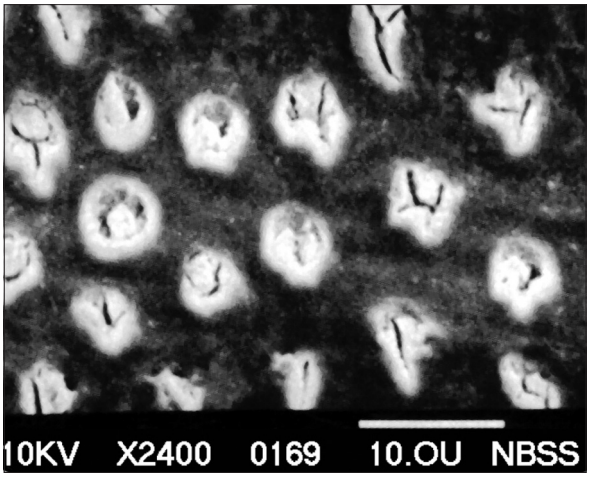


**Figure 3:** Scanning electron microscope photograph of Group A, i.e., 21.3% aluminum chloride

pattern was not seen. The debris was accumulated in clusters indicating intact smear layer [Figure 4].

In Group C, i.e., expasyl paste treated samples, mass of debris was seen. Along with that, some of the dentinal tubules were showing recognizable tubular pattern with cracks across tubular opening. All the tubules were occluded. This group revealed partially removed smear layer with occluded dentinal tubules [Figure 5].

SEM examination revealed that Group B produced no alteration to smear layer followed by minimum alteration by Group C and complete removal of smear layer with etching of dentin with Group A.

## Discussion

Researchers have confirmed that tooth preparation by rotary instrumentation would results in the production of smear layer on the remaining dentin;[5,6] the thickness of smear layer may vary from 0.5 to 15 um depending upon the method of instrumentation.[7-9] According to Pashley, the smear layer acts as a beneficial cavity liner instrumental in protecting the tooth from postpreparation sensitivity, even better than commercially available cavity liners.[7] on the contrary, Brännström advocated the removal of smear layer so as to provide better adaptation of lining and luting materials.[10] Some investigators recommend removal of smear layer to improve the bond strength of certain dentin bonding agents[11] while other are in favor to maintain the thickness of smear layer composite resin restoration placed without glass ionomer liners.[12] Researchers have confirmed that chemical agents remove the smear layer to various degrees such as use of 37% phosphoric acid for 15 s,[10] 10% of polyacrylic acid for 20 s,[11] and even 25% of tannic acid for 60 s.[13] Land *et al*. concluded that 21.3% aluminum chloride and 8% racemic epinephrine hydrochloride the removed greatest amount of smear layer.[14] New hemostatic agents such as 0.05% oxymetazoline hydrochloride or 0.025% tetrahydrozoline hydrochloride are also effective hemostatic solutions.[15] Cordless displacement material such as expasyl had been introduced as an alternative to liquid hemostatic solutions, and it proved to be effective and more user-friendly.[16] Hence, in this study, it was decided to evaluate the effect of these chemical agents on smear layer.

Researches have also found relationship between pH and amount of smear layer removal.[14] In this study, to establish the relationship between thicknesses of smear layer with pH of the hemostatic solutions, the pH of all the three groups were determined using pH meter.

Laufer *et al*. through their study concluded that to achieve a crevicular width of 0.2 mm, cord should remain in the gingival crevice for an optimum time of 4 min prior to impression making.[17] However, contemporary textbooks recommended that the cord should remain in the gingival crevice for an optimum time of 10 min. Hence, liquid hemostatic solution, i.e., Groups A and B, was allowed to remain in contact with prepared tooth for 10 min.

In our study, pH of all three groups were determined by pH meter and found that Group A, i.e., 21.3% aluminum chloride had least pH of 1.82 followed by Group C, i.e., expasyl paste containing kaolin and aluminum chloride, of 3.86. Group B, i.e., 0.05% oxymetazoline hydrochloride was found to be 6.44.

It is a logical relationship that with acidic pH of retraction agents, the smear layer is bound to be altered. With more acidity, there is more alteration of smear layer and dentin. Therefore, to avoid this alteration, alternative would be to use a retraction agent that has a neutral/alkaline pH.

However, chemicals used for retraction are not stable in alkaline pH and therefore, some alteration of the smear layer and dentin is to be expected. Hence, from the pH meter reading, one can propose that 0.05% oxymetazoline

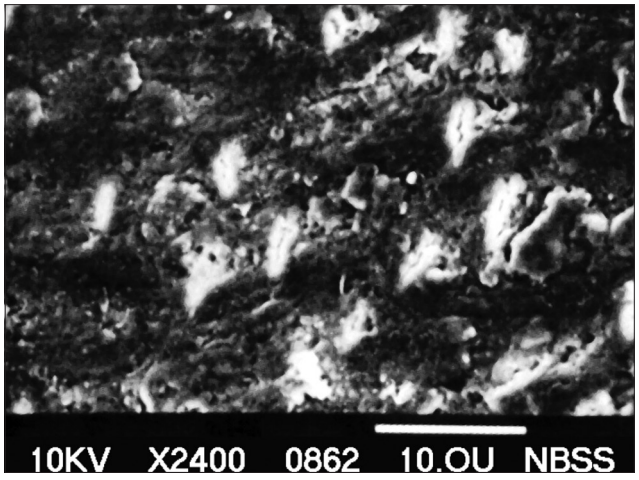


**Figure 4:** Scanning electron microscope photograph of Group B, i.e., 0.05% oxymetazoline hydrochloride

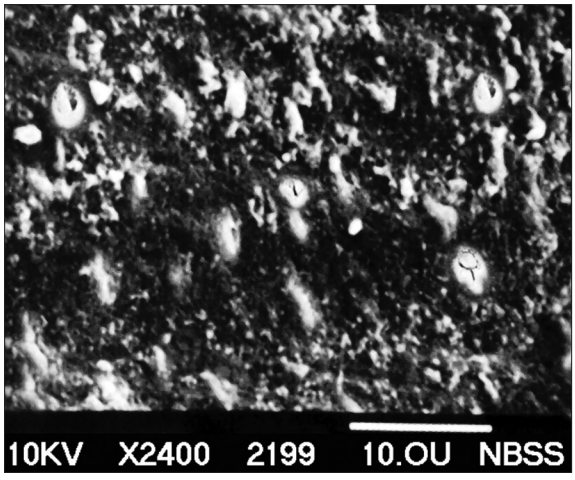


**Figure 5:** Scanning electron microscope photograph of Group C, i.e., expasyl paste

hydrochloride (pH-6.44) would alter the tooth structure minimally, and 21.3% aluminum chloride (pH-1.82) would have maximum effects. Expasyl paste containing of kaolin and aluminum chloride (pH-3.86) would have intermediate changes.

To observe the effect of these retraction agents has on the prepared tooth structure, an SEM observation was felt necessary. The samples thus were prepared for SEM examination. Prepared were treated with respective groups of retraction agents for corresponding period. SEM examination of representative sample revealed that Group A, i.e., 21.3% aluminum chloride sample showed complete removal of smear layer with opened dentinal tubules and visible etching of dentin. SEM observation of Group B, i.e., 0.05% oxymetazoline hydrochloride treated sample showed intact smear layer. SEM photographs of Group C revealed partially removed smear layer with occluded dentinal tubules. The results of this study are similar to Woody *et al*. where they concluded that oxymetazoline hydrochloride and tetrahydrozoline hydrochloride have a more acceptable pH and should be kind to the tooth structure.[18]

This revealed that Group B produced no alteration to smear layer followed by minimum alteration by Group C and complete removal of smear layer with etching of dentin with Group A. The results of this study are in consistent with the results obtained by Land *et al*.[19] indicating that more the hemostatic solution is acidic, more the smear layer removal. 21.3% aluminum chloride showed detrimental effects on smear layer and dentin. 0.05% oxymetazoline hydrochloride having nearly neutral pH provides no alteration to smear layer. As expasyl had higher pH than 21.3% aluminum chloride and lower pH than 0.05% oxymetazoline hydrochloride, it showed intermediate changes. The period of 2 min further reduced the effect that aluminum chloride in paste form might have.

### Limitations of the study

- Results of this study need to be verified with other chemicals with variation in time
- Results of the study are to be evaluated on other teeth of both maxillary and mandibular arch.

## Conclusion

From the SEM examination, it is evident that Group B, i.e., knitted cord impregnated with 0.05% oxymetazoline hydrochloride produced no alteration to smear layer followed by minimum alteration by Group C, i.e., expasyl paste retraction system. Complete removal of smear layer with etching of dentin was demonstrated in Group A sample i.e., knitted cord impregnated with 21.3% aluminum chloride. Hence, showing that oxymetazoline hydrochloride and expasyl are kind to smear layer and tooth structure.

All science is concerned with the relationship of cause and effect. Each scientific discovery increases man's ability to predict the consequences of his actions and thus his ability to control future events with scientific research being its lifeline. Much has been done and will be done till the optimum ideal is achieved.

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### Conflicts of interest

There are no conflicts of interest.

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