

Assessment of the Smear Layer Removal Efficacy of Three Different Agents on Periodontally Compromised Tooth: An *In Vitro* Study

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ABSTRACT

Aim: The purpose of the present study was to evaluate the smear layer removal efficacy of three various agents on periodontally compromised tooth.

Materials and methods: The current study included 75 molar teeth that were extracted due to periodontal disease. After that, 25 samples were randomly assigned using a simple random technique to the three different agent groups, group A: Scaling and root planing (SRP) and application of SofScale agent, group B: SRP and application of QMix agent, group C: SRP and application of MTAD agent. Using a diamond circular saw, the treated portions were divided into horizontal and vertical halves. All samples were viewed under Scanning Electron Microscope. Every tooth was focused at the coronal third, middle third, and apical third portion with a magnification of 1000×. Data were recorded and statistically analyzed.

Results: The smear layer removal efficacy was more in the QMix agent (3.06 ± 0.04) group followed by MTAD agent (3.28 ± 0.09) and SofScale agent (4.14 ± 0.10) group on the root surface. On intra group comparison, there was a statistically significant difference found in all the intra group agents with all the three levels. On inter group evaluation, at coronal third, there was no significant difference found between the different agents. There was a significant difference found between the different agents at middle and coronal third.

Conclusion: On conclusion, the current investigation found that, the root surfaces treated with QMix shown a greater ability to remove smear layers compared to tooth surfaces treated with MTAD and SofScale agent.

Clinical significance: Conventional therapies such as SRP effectively eliminate calculus, plaque, and necrosed cementum; nevertheless, they leave behind a smear layer that could impede normal healing. In an effort to overcome this, root conditioning agents were applied on the root surface to remove the smear layer. The traditional root conditioning agents such as citric acid have certain disadvantages, though, such as an acidic pH that could harm the root surface. As a result, researchers have been looking for biocompatible root conditioning treatments that are more effective.

Keywords: Chemical agents, Periodontally compromised tooth, Scaling and root planing, Smear layer.

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INTRODUCTION

A bacterial plaque and the subgingival environment are exposed to the root surface in periodontal disease. The root cementum changes both chemically and physically when exposed to crevicular fluid and the enzymes and metabolites that subgingival plaque bacteria create. Bacterial plaque, hypermineralization, and other cytotoxic agents are present on the root surfaces of patients with periodontitis.¹

Traditional scaling and root planing (SRP) treatment have relied on the mechanical removal of plaque, calculus, root-bound toxins, and contaminated cementum. The effectiveness of SRP has been questioned despite its well-documented effectiveness. Furthermore, the residual smear layer following instrumentation could impede periodontal repair.²

Attempts have been made to remove the smear layer by utilizing root conditioning agents, which started with the addition of different acids. The efficacy of root conditioning agents was thought to be due to the acid exposing collagen fibrils in the dentin matrix, which gave the nidus a perfect place to splice with new fibrils when the wound healed.³ The root surface's dentin matrix is exposed, which facilitates the formation of a healthy fibrin clot and the favorable outcome of early wound healing events. This

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amalgamation between the root surface and the healing connective tissue then favors gingival fibroblast migration and attachment. Therefore, the application of chemical conditioning agents aids in the preparation of the roots by removing the surface mineral matter along with cytotoxic material and products formed from bacteria that impact the root surfaces.⁴

SofScale is made up of chelating chemicals that help dissolve calculus, such as detergent sodium lauryl sulphate and disodium EDTA. QMix is composed of a combination of bisbiguanide antibacterial, a polyaminocarboxylic acid calcium-chelating substance, saline, plus surfactant that are documented to be remarkably effective against microbial plaque.⁵ The two compounds found in MTAD that are most frequently used in the biomodification of root surfaces are citric acid and doxycycline. The most effective inhibitor of collagenase is doxycycline. The possibility of chemically dissolving calculus and contaminated root cementum.⁶ In order to restore the damaged root surface's biocompatibility a prerequisite for the new attachment of periodontal structures, the majority of regeneration treatments call for its modifications and disinfection. Additionally, there is a lack of information about SofScale, QMix, and MTAD agents' comparisons. Hence, the present study was conducted to evaluate the smear layer removal efficacy of SofScale, QMix, and MTAD agents on periodontally compromised tooth.

MATERIALS AND METHODS

The present *in vitro* study was conducted in the Department of Periodontology, Kalinga Institute of Dental Sciences, Bhubaneswar, India, during the year of 2023. Institutional approval was obtained for the present study. Total of 75 molar teeth that were removed due to periodontal disease were included. The study comprised intact teeth and had normal root morphology; teeth that had any pulpal involvement (caries), as well as teeth with cervical abrasion, erosion, and restorations were not included. These teeth were stored in saline till further treatment on the root surface.

Then, using a basic randomization technique, the chosen teeth were divided into three groups, each including 25 samples, and these groups were as follows:

1. Group A: SRP and application of SofScale agent: On each root surface, SofScale (Dentsply Sirona, USA) was administered for 2 minutes to the targeted area. Radicular surfaces were instrumented in an apico-coronal direction parallel to the tooth axis using Gracey curettes.
2. Group B: SRP and application of QMix agent: Following a 2-minute QMix agent (Dentsply Sirona, USA) application period, Gracey curettes (Hu-Friedy, Chicago, IL, USA) were used to instrument the radicular surfaces.
3. Group C: SRP and application of MTAD agent: Using a gentle brush, MTAD agents (Dentsply Tulsa, USA) were administered to the samples for duration of 2 minutes. Gracey curettes were then used to instrument the radicular surfaces.

Tooth Section Preparation for Scanning Electron Microscopy

Following the application of the root conditioners, 20 mL of saline were used to rinse the root surface. Afterward, the cemento-enamel juncture was where the crowns were removed. Using a diamond circular saw, the treated portions were divided into horizontal and vertical halves to assess the coronal, middle, and apical third portions. After rinsing each tooth part with saline,

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they were left in a 0.1 M phosphate buffer solution containing 2.5% glutaraldehyde for a whole day. After removing from 2.5% glutaraldehyde solution in 0.1 M phosphate buffer, the samples were washed and dehydrated in graded alcohol solutions of 50, 70, 80, 95, and 100% for 10 minutes. The samples underwent two further washing in pure alcohol before being allowed to dry in a desiccator jar for the overnight.

Sputter Coating for Scanning Electron Microscopy

Using a sputter coating machine, the teeth were taken out of the desiccator jar, placed on the SEM stubs, and then coated in gold. Every tooth was focused under Scanning Electron Microscope (Carl Zeiss EVO) at the coronal third, middle third, and apical third portion with a magnification of 1000×. Following computer generation, the final image was examined using the following criteria and two investigators participated in the scoring system:

- Score 1: There is no sign of a smear layer in the spaces between the dentinal tubules and the root surface, which has the dentinal tubules fully opened.
- Score 2: Smear layer absent from the root surface; dentinal tubules fully open; smear layer visible in the spaces between the dentinal tubules.
- Score 3: Root surface with slightly opened dentinal tubules and no smear layer.
- Score 4: Smear layer covering the root surface; homogeneous appearance; dentinal tubule gaps visible.
- Score 5: Smear layer covers the root surface, which has a homogeneous look and shows no signs of dentinal tubule gaps.
- Score 6: The root surface has a smear layer covering it, an uneven surface, and grooves and/or scattered debris.

Statistical Analysis

The SPSS software version 17 was used to analyze the data Mann–Whitney and the Kruskal–Wallis test. The *U* test was utilized to evaluate and compare the differences in smear layer removal effectiveness across the different groups. A statistically significant *p*-value was defined as one that was less than 0.05.

RESULTS

Table 1 and Figure 1 show the smear layer removal of three different chemical agents on root surface. The smear layer removal efficacy was better in the application of QMix agent (3.06 ± 0.04) followed by application of MTAD agent (3.28 ± 0.09) and application of SofScale agent (4.14 ± 0.10) on the root surface.

Table 2 depicted the intra group evaluation of three different chemical agents on root surface at coronal third, middle third, and apical third. After application of SofScale agent, the smear layer removal at coronal third was 2.04 ± 0.01 , middle third was 1.16 ± 0.05 , and apical third was 0.94 ± 0.04 . After application of QMix agent, the smear layer removal at coronal third was 2.10 ± 0.01 , middle third was 0.58 ± 0.01 , and apical third was 0.38 ± 0.02 . After application of MTAD agent, the smear layer removal at coronal third was 2.08 ± 0.03 , middle third was 0.74 ± 0.02 , and apical third was 0.46 ± 0.04 .

There was a statistically significant difference found in all the intra group agents with all the three levels.

Table 3 shows the inter group assessment of three different chemical agents on root surface at coronal third, middle third, and apical third. At coronal third, the mean smear layer removal of SofScale agent was 2.04 ± 0.01 , QMix agent was 2.10 ± 0.01 , and MTAD agent was 2.08 ± 0.03 . And there was no significant difference found between the different agents. At middle third, the mean smear layer removal of SofScale agent was 1.16 ± 0.05 , QMix agent was 0.58 ± 0.01 , and MTAD agent was 0.74 ± 0.02 . At apical third, the mean smear layer removal of SofScale agent was 0.94 ± 0.04 , QMix agent was 0.38 ± 0.02 , and MTAD agent was 0.46 ± 0.04 . And there

was a significant difference found between the different agents at middle and coronal third.

The inference of the present study includes that the, root surfaces treated with QMix showed a better smear layer removal ability as compared to tooth surfaces treated with MTAD and SofScale agent.

DISCUSSION

Collagen fibers may become visible as a result of root planing and smear layer removal. This could enhance periodontal ligament cell migration and adhesion to the root surface, promoting periodontal healing.⁷ Regenerative periodontal therapy utilizes various biomaterials in the form of bone grafts, guided tissue regeneration, emdogain, etc. But because of the smear layer, which functions as a physical barrier between the periodontium and the root and prevents the creation of new attachment, none of these can be integrated with the root.⁸

Smear layer is composed of remnants of dentin, cementum, endotoxins from bacteria, and residual calculus. The past few decades have seen the usage of root biomodification chemicals in an effort to remove this smear layer prior to any regenerative operation.⁹ Acid etching is one of the suggested methods to detoxify the root surface. In addition to etchants, various detoxification agents that were mostly acids and could affect the health of the surrounding periodontal tissues were utilized, such as citric acid, tetracycline HCl, maleic acid, EDTA, etc.¹⁰

However, by enhancing blood cell and fibrin adhesion on the root surface, or even by increasing the retention and contact of certain substances like enamel matrix, which would act as a growth factor, the exposition of dentinal tubules may be an ancillary factor in clot stabilization in the early stages of periodontal healing. After SRP, many different substances some with a higher potential for cytotoxicity than others have been suggested for root surface therapy.¹¹ The SofScale, QMix, and MTAD agents which contain chemicals that efficiently remove the smear layer were used in the current investigation. SofScale is composed of chelating ingredients including disodium EDTA and detergent sodium lauryl sulfate that aid in dissolving calculus. QMix is composed of a combination of bisbiguanide antibacterial, a polyaminocarboxylic acid calcium-chelating substance, saline, plus surfactant that are documented to be remarkably effective against microbial plaque. The MTAD contains citric acid and

Table 1: Mean smear layer removal of three different chemical agents on root surface

Chemical agents	N	Mean \pm SD (μ m)
Group A: Application of SofScale agent	25	4.14 \pm 0.10
Group B: Application of QMix agent	25	3.06 \pm 0.04
Group C: Application of MTAD agent	25	3.28 \pm 0.09

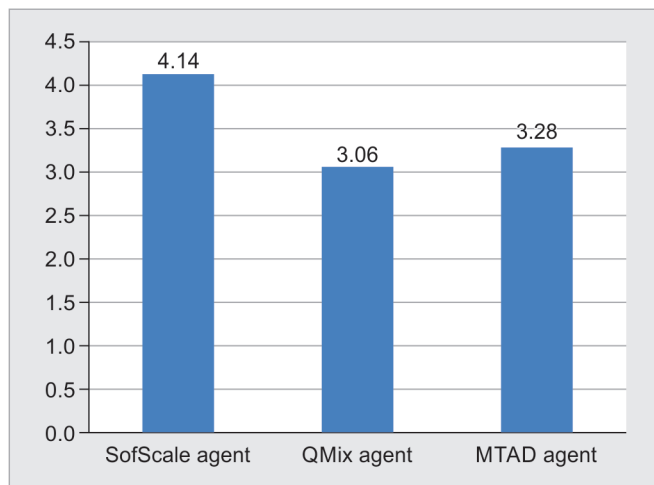


Fig. 1: Overall mean smear layer removal efficacy of three various chemical agents on root surface

Table 2: Intra group assessment of three different chemical agents on root surface at coronal third, middle third, and apical third

Chemical agents	Coronal (Mean \pm SD)	Middle (Mean \pm SD)	Apical (Mean \pm SD)	K ANOVA value	p-value
Group A: Application of SofScale agent	2.04 \pm 0.01	1.16 \pm 0.05	0.94 \pm 0.04	19.58	0.001
Group B: application of QMix agent	2.10 \pm 0.01	0.58 \pm 0.01	0.38 \pm 0.02	18.62	0.001
Group C: application of MTAD agent	2.08 \pm 0.03	0.74 \pm 0.02	0.46 \pm 0.04	19.14	0.001

Table 3: Inter group assessment of three different chemical agents on root surface at coronal third, middle third, and apical third

Chemical agents	Coronal (Mean \pm SD)	Middle (Mean \pm SD)	Apical (Mean \pm SD)
Group A: Application of SofScale agent	2.04 \pm 0.01	1.16 \pm 0.05	0.94 \pm 0.04
Group B: application of QMix agent	2.10 \pm 0.01	0.58 \pm 0.01	0.38 \pm 0.02
Group C: application of MTAD agent	2.08 \pm 0.03	0.74 \pm 0.02	0.46 \pm 0.04
K ANOVA value	24.18	23.36	24.03
p-value	0.954	0.001	0.001

doxycycline, the two materials with the most usage among other materials in biomodification of root surface. Doxycycline has the most inhibiting effect on collagenase.⁶

In the present study, the smear layer removal efficacy was better in the application of QMix agent followed by application of MTAD agent and application of SofScale agent on the root surface. This was consistent with Shewale and Gattani¹² research as, the advantages of QMix stem from a number of its ingredients, including EDTA, CHX, and a detergent that acts as a surface-active agent. QMix was found by Dai et al.¹³ to be as effective in removing smear layers as 17% EDTA. Using SEM, Stojicic et al.¹⁴ evaluated QMix's efficacy and capacity to remove smear layers, and they concluded that QMix outperformed other materials in laboratory settings.

In the present study, the smear layer removal efficacy was better in the application of MTAD agent compared to the application of SofScale agent on the root surface. In a study by Calt S and Serper,¹⁵ the agent was applied for 4 minutes after SRP, at which point the proper efficacy of MTAD was determined. This technique demonstrated unparalleled outcomes in the attachment and proliferation of the periodontal ligament cells in addition to eliminating the radicular surface smear layer. Dentinal micro-hardness can be reduced by 17.33–29.48% with MTAD, according to Scelza et al.¹⁶ This was a much better result than with other agents. Actually, the utility of MTAD in clinical practice is greatly advantageous due to its natural pH and its capacity to remove the radicular surface smear coat.

One of the study's limitations is that the quantity of localized nonmineralized and mineralized deposits on the root surface may have an impact on the severity and type of periodontal disease. Other variables that may affect the conditions of radicular dentin and, in turn, the amount of smear layer formed include the patient's age and diet- and oral hygiene-related problems (such as the use of toothpaste, mouth rinses, and low-pH beverages). Therefore, additional research incorporating these variables is advised in order to assess its effectiveness in clinical settings as well.

CONCLUSION

Within the limitation, the current investigation found that, the root surfaces treated with Qmix shown a greater ability to remove smear layers compared to tooth surfaces treated with MTAD and SofScale agent. Since all the study agents have demonstrated their biological acceptability, clinical trials are advised in order to validate the findings.

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