

Original Research Article

An In-vitro Evaluation of the Efficacy of MTAD, Maleic Acid and EDTA for Smear Layer Removal Using Two Different Irrigating Needles After Biomechanical Preparation – A Scanning Electron Microscope Study.

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Abstract: To evaluate the efficacy of irrigating solutions EDTA, MTAD and Maleic acid in smear layer removal, using Navitips and conventional needles. 48 extracted mandibular premolar teeth were divided into 3 groups and two subgroups. They were prepared by ProTaper Ni Ti instrument system to an apical size of F3. The final irrigation in each group was done as follows, Group 1A- 17% EDTA (Control Group) with conventional needle, Group 1B-17% EDTA with Navitip, Group 2A- MTAD with conventional needle, Group 2B- MTAD with Navitip, Group 3A- 7% Maleic acid with conventional needle, Group 3B- 7% Maleic acid with Navitip. After final rinse with the test irrigants, the specimens were dried and prepared for SEM examination. In Group 2, MTAD was used, most root canal surfaces in coronal, middle and apical thirds had no smear layer. The coronal and middle third areas showed complete smear layer removal in 88 % and 75 % of samples, respectively, using both Conventional needle and Navitip. In apical third 63 % of samples, using Navitip and 50 % of samples, using Conventional needle, showed complete smear layer removal. Group 2 (MTAD) showed the best result for the removal of smear layer in all the areas. Group 3 (Maleic acid) and Group 2 (MTAD) are equally effective in the apical third, without much significant difference. Navitips are effective in the removal of smear layer than the Conventional needles, but there was no significant difference between them.

Keywords: EDTA, MTAD, Maleic acid, irrigating solutions, Navitips.

INTRODUCTION

Cleaning and disinfection of the root canal system is one of the main objectives of biomechanical preparation. The current method of cleaning and shaping root canals produces a smear layer that covers the instrumented walls. The smear layer is composed of debris, organic material and microorganisms that adhere to the walls, obstructing the opening of the tubules. It may also prevent the penetration of anti-microbial agents into the tubules, as well as adhesion of root canal sealers to the canal walls, thus compromising the quality of obturation [1,2]. Hence its elimination is important for the success of the endodontic treatment.

There are various methods to eliminate smear layer in clinical practice, which include chemical, mechanical modes and lasers [3]. Irrigation facilitates cleaning of the root canal system by flushing debris as well as serving as a bactericidal agent, tissue solvent and lubricant. EDTA is the commonly used irrigant after instrumentation, because of its chelating action; it removes both inorganic and organic components of the

smear layer. Maleic acid has been found to possess the smear layer removing quality when used as an acid etchant in restorative dentistry. It is shown that 5% and 7% maleic acid can be an alternative to routine use of 17% EDTA, in endodontics. The introduction of MTAD, an aqueous solution of 3% doxycycline, 4.25% citric acid, and 0.5% polysorbate 80 (polyethylene sorbitol ester) detergent, represents a clinical effective endodontic irrigation technique [2, 4]. When MTAD is used as directed, it is proven to effectively remove the smear layer with less erosion to the dental structure than EDTA. Navitips offer controlled delivery of irrigants to the apex. They feature a safe round end and mostly rigid shanks – the last few millimeters are flexible to facilitate navigation through curved canals, without crimping and ledging. Navitips have double side ports which deliver irrigants safely, minimizing the possibility of chemicals being expressed past the apex. The purpose of this SEM study is to compare the efficacy of different irrigating solutions (MTAD, Maleic acid and EDTA) for the smear layer removal from the root canals, after instrumentation, using two

different irrigating needles i.e, the Navitips and the Conventional needles.

MATERIALS AND METHOD

Forty eight freshly extracted mandibular single rooted premolar teeth with straight roots were taken and coronal part of the teeth was decoronated using a double sided diamond disk at the level of the cemento enamel junction, The external surface of each root was grooved longitudinally, on labial and lingual side, to aid splitting of the specimens before subjecting to SEM examination. All the specimens were randomly divided into 3 groups containing 16 teeth each. They are further subdivided into 2 groups of 8 teeth each. All the specimens were prepared by Rotary Protaper instrument system to an apical size of F3. In all the Groups, Normal Saline and 1.3% Sodium Hypochlorite were used alternately as irrigants during instrumentation. A total of 10 ml of irrigants were used in each root canal. The irrigants were delivered using 28 Gauge (G) Conventional needles that penetrated to within 1-2 mm from the working length in each canal in subgroup A and using 31 G Navitips that penetrated to within 1-2 mm from the working length in each canal in subgroup

B. The instrumentation time for each canal was approximately 15 – 20 minutes.

In all the groups, instrumentation was followed by rinsing the canal with 10 ml of sterile distilled water to minimize potential interactions of sodium hypochlorite with any of the test irrigants employed as the final rinse. All specimens in the groups were subjected to 5 ml of the respective group irrigant as the final rinse using 28 G Conventional needles in subgroup A and using 31 G Navitips in subgroup B. After completion of the final rinse, the canals were irrigated with 10 ml of sterile distilled water and dried with sterile paper points. Each specimen was split into two with chisel and mallet along the prepared groove and sent for Scanning Electron Microscopic (SEM) examination. Photomicrographs were taken at 2500X magnification at 3 different levels i.e. coronal, middle and apical thirds, Figure1 and 2.

The following Table 1 shows the irrigant used during instrumentation and the test irrigants used as the final rinse in each group.

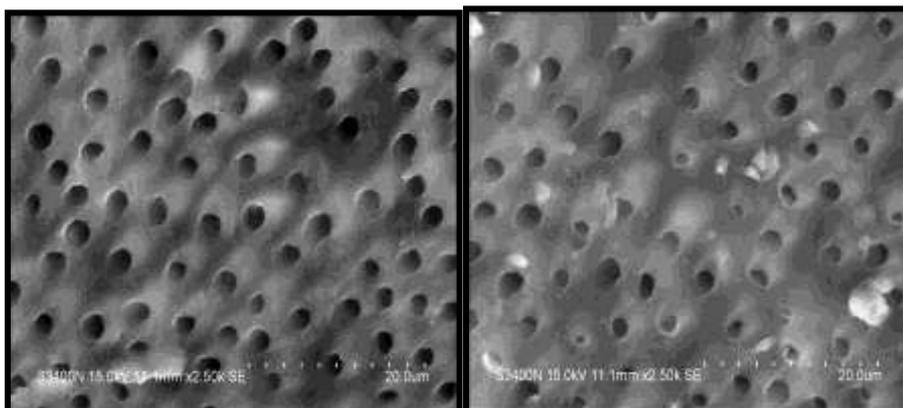


Fig-1: SEM photomicrograph of Group 2B Figure 2: SEM photomicrograph of Group 2B (MTAD, Navitip) at coronal third.(MTAD, Navitip) at apical third.

Table-1: Chart of Procedure

| Group | Irrigating solution during root canal preparation | Final rinse solution for removal of smear layer |
|-------|--|--|
| 1A | 1.3% Sodium hypochlorite and Normal saline used alternately. | EDTA 17% EDTA solution, using a 28 G Conventional needle. |
| 2A | 1.3% Sodium hypochlorite and Normal saline used alternately. | MTAD Tetracycline isomer, 4.25% citric acid, and detergent (Tween 80),using a 28 G Conventional needle. |
| 3A | 1.3% Sodium hypochlorite and Normal saline used alternately. | MALEIC ACID 7% Maleic acid solution, using a 28 G Conventional needle. |
| 1B | 1.3% Sodium hypochlorite and Normal saline used alternately. | EDTA 17% EDTA solution, using a 31 G Navitip. |
| 2B | 1.3% Sodium hypochlorite and Normal saline used alternately. | MTAD Tetracycline isomer, 4.25% citric acid, and detergent (Tween 80), using a 31 G Navitip. |
| 3B | 1.3% Sodium hypochlorite and Normal saline used alternately. | MALEIC ACID 7% Maleic acid solution, using a 31 G Navitip. |

RESULTS

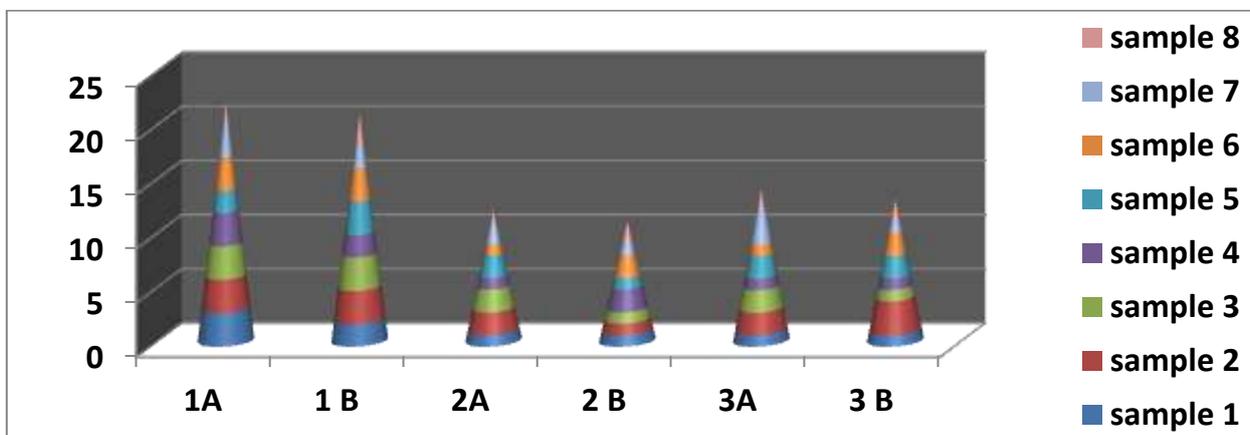
The analysis was performed using SPSS version 14, Mean value comparison among the groups was done using ANOVA followed by post hoc Tukey’s HSD test. On comparison, Group 2 (MTAD) showed the best result for the removal of smear layer in all the areas i.e; coronal, middle and apical third of the root canal when compared to Group 1 (EDTA) and Group 3 (Maleic acid). Group 3 (Maleic acid) and Group 2

(MTAD) are equally effective in the apical third, without much significant difference, as shown in the Table 2 and Graph 1. Navitips are effective in the removal of smear layer than the conventional needles, but there was no significant difference between them. No statistically significant difference was found among Group 1 (EDTA), Group 2 (MTAD) and Group 3 (Maleic acid), with Conventional needles or Navitips, in coronal and middle third for the removal of smear layer.

Table-2: Comparison of smear layer removal among the three groups at Apical third

| Site | Group | N | Mean | Std. Deviation | p-value |
|---------------|--------------|---|-------|----------------|---------|
| Apical 1/3 rd | 1 A (EDTA/C) | 8 | 2.75 | 0.463 | 0 |
| | 1 B (EDTA/N) | 8 | 2.625 | 0.518 | |
| | 2A (MTAD/C) | 8 | 1.5 | 0.535 | |
| | 2B (MTAD/N) | 8 | 1.375 | 0.518 | |
| | 3A (M.A/C) | 8 | 1.75 | 0.707 | |
| | 3 B (M.A/N) | 8 | 1.625 | 0.744 | |

| Post - HocTest | Comparison | Significant? (P <0.05?) | t |
|----------------|------------|-------------------------|-------|
| | 1: 1a-1b | No | 0.424 |
| | 2: 1a-2a | Yes | 4.238 |
| | 3: 1a-2b | Yes | 4.662 |
| | 4: 1a-3a | Yes | 3.39 |
| | 5: 1a-3b | Yes | 3.814 |
| | 6: 1b-2a | Yes | 3.814 |
| | 7: 1b-2b | Yes | 4.238 |
| | 8: 1b-3a | No | 2.967 |
| | 9: 1b-3b | Yes | 3.39 |
| | 10: 2a-2b | No | 0.424 |
| | 11: 2a-3a | No | 0.848 |
| | 12: 2a-3b | No | 0.424 |
| | 13: 2b-3a | No | 1.271 |
| | 14: 2b-3b | No | 0.848 |
| 15: 3a-3b | No | 0.424 | |



Graph-1: Comparison of EDTA, MTAD and Maleic acid in apical third for smear layer removal.

DISCUSSION

The presence or absence of a smear layer plays an important role in the adhesiveness of some sealers to the root canal walls. Removal of smear layer allows greater penetration of the root canal sealers into the dentinal tubule openings aiding an intimate adaptation of the obturating materials with the prepared canal walls.⁵ There is no single irrigating solution that alone sufficiently covers all of the functions required for an irrigant. Optimal irrigation is based on the combined use of two or several irrigating solutions in a specific sequence to predictably obtain the goals of safe and effective irrigation. Various agents like organic acids, chelating agents, ultrasonics and lasers have been used to remove the smear layer. However, search continues for newer and better agents for removal of smear layer. Among the recently introduced irrigants, MTAD and Maleic acid were used in the present study. Both the solution are used as a final rinse for removing the smear layer from surface of the root canal.

In Group 2, where a combination of sodium hypochlorite and MTAD was used, most root canal surfaces in coronal, middle and apical thirds had no smear layer. The coronal and middle third areas showed complete smear layer removal in 88 % and 75 % of samples, respectively, using both Conventional needle and Navitip. In apical third 63 % of samples, using Navitip and 50 % of samples, using Conventional needle, showed complete smear layer removal. In rest of the samples only moderate amount of smear layer was observed. None of the samples showed heavy smear layer. These findings are in agreement with the study conducted by Mahmoud Torabinejad *et al.* [6], in the ten samples irrigated with 1.3 % Sodium Hypochlorite and MTAD, they found 27 out of 30 root canal surfaces having complete smear layer removal.

The effectiveness of Biopure MTAD is attributed to its anticollagenase activity, low pH and its ability to be released gradually over time. In addition, presence of a detergent (Tween 80) reduces its surface tension and thus improves its penetration over the deeper layers of dentin.⁷ The cleaning ability of tetracycline based MTAD can be attributed to its ability to chelate calcium. Tetracyclines are broad spectrum antimicrobials. They can bind directly to the demineralized dentinal surfaces and maintain antimicrobial activity by being subsequently released.

The results of the present study showed that smear layer removal was better in Group 2 (MTAD) when compared to Group 1 (EDTA), and Group 3 (Maleic acid). But Group 2 (MTAD) and Group 3 (Maleic acid) are equally effective in the apical third, without much significant difference. Nidambur Vasudev Ballal *et al.* [3, 8] who confirmed that 7% Maleic acid is more efficient than 17% EDTA in the removal of smear layer from the apical third of the root canal system. This may be due to the surface

tension of 17% EDTA is higher than that of 7% maleic acid [9]. Because EDTA is a chelating agent, it is not dependent on a high hydrogen ion concentration to accomplish decalcification and is effective at a neutral pH. The exchange of calcium from dentin by hydrogen results in a subsequent decrease in pH. Hence, the efficacy of EDTA decreases over time because of the decrease in pH. Since Maleic acid is highly acidic, it has a better demineralizing effect within a shorter period of time.

In this study, Subgroup B (Navitips) are effective in the removal of smear layer than the Subgroup A (Conventional needles), but there was no significant difference between them, in the coronal, middle and apical third, using the three irrigating solutions. A 31 gauge, 21mm Navitip is used in this study, as this needle is stiff close to the hub, but extremely flexible toward the tip, allowing the rounded end to negotiate complicated apical anatomy. Edgar Schafer [10] recommended flexible irrigation needles with a safety tip so that the needle can be pre-bent according to the canal curvature to allow proper cleaning of the apical part of curved root canals [10].

CONCLUSION

The conclusion drawn, within the limitations of this study:

- Group 2 (MTAD) showed the best result for the removal of smear layer in all the areas i.e; coronal, middle and apical third of the root canal when compared to Group 1 (EDTA) and Group 3 (Maleic acid).
- Group 3 (Maleic acid) and Group 2 (MTAD) are equally effective in the apical third, without much significant difference.
- Navitips are effective in the removal of smear layer than the Conventional needles, but there was no significant difference between them.

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