Evaluation of Long-Term Success Rates of MTAD and EDTA as Final Rinsing Solution in Root Canal Irrigation: A Retrospective Analysis

Sofia Rodriquez Fitzpatrick[1] Richard J. Gray[2] Robert Handysides[2] Sarah Al Tally[1] Madeleine Everett[1] Bradley DeVine[1] Udochukwu Oyoyo[3] So Ran Kwon[1]

[1] Division of General Dentistry, Loma Linda University School of Dentistry, Loma Linda, California, United States
[2] Department of Endodontics, Loma Linda University School of Dentistry, Loma Linda, California, United States
[3] Dental Education Services, Loma Linda University School of Dentistry, Loma Linda, California, United States

Address for correspondence Sofia Rodriquez Fitzpatrick, DDS, Loma Linda University School of Dentistry, 11092 Anderson St., Loma Linda, CA 92350, United States (e-mail: srodriguezlopez@llu.edu).

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Abstract

Introduction Endodontic therapy aims to disinfect the root canal system, and irrigating solutions play an important role in this process. Although many irrigating solutions are available, the search for an ideal one is still in progress. The debate currently exists if the removal of the smear layer is a critical component to the success rate of endodontic therapy.

Aim The aim of the study was to compare BioPure MTAD (a mixture of doxycycline, citric acid, and detergent [Tween 80]) versus ethylenediaminetetraacetic acid (EDTA, Pulpdent 17%) as a final rinse in endodontically treated teeth prior to obturation.

Methodology A total of 106 root canal cases, treated by endodontic residents at Loma Linda University, were identified. These cases were evenly divided between the use of MTAD and EDTA as a final rinse. Radiographic analysis was performed on these cases, and a periapical index (PAI) score was assigned at the start of treatment and again at the final follow-up recall. Root canal success was defined as a final PAI score of 1 or 2.

Results Statistical analysis showed no significant difference in success rates between cases using MTAD and EDTA. These findings indicate that both irrigants have similar long-term clinical effectiveness in endodontic therapy.

Conclusion This study contributes evidence to existing research showing no significant difference in the long-term clinical effectiveness of MTAD compared with EDTA as an irrigant in root canal treatment in terms of antimicrobial effect.

Keywords
- EDTA
- MTAD
- irrigants
- endodontics
- root canal treatment
- PAI score

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Introduction

The main goal of endodontic therapy is to clean and disinfect the root canal space, both chemically and mechanically. In cleaning, irrigation is the most important factor for allowing the healing of periapical tissues.[1,2] Different microorganisms have been previously identified as having the ability to invade the various anatomic irregularities and dentinal tubules of the root canal system.[3,4] The smear layer produced during root canal preparation can become packed into accessory canals and the main root canal wall.[5,6] Removing the smear layer is essential because it houses bacteria, acts as a substrate for bacterial growth, and can act as a barrier between the sealer and the root canal wall.[7–9] *Enterococcus faecalis* is commonly isolated with persistent endodontic infections; because of its association with endodontic failure, irrigants have been developed with an antibacterial component to target *E. faecalis*.[10,11] Ideally, an irrigant should possess several key qualities: it should be antimicrobial, capable of dissolving necrotic pulp tissue and the smear layer, inactivating endotoxins, and nontoxic to vital tissues. Additionally, it must disinfect the dentin and its tubules, be biocompatible with live host tissues, and serve as a lubricant for root canal instruments.[12] Two irrigants, among many used in endodontic therapy, are ethylenediaminetetraacetic acid (EDTA),[13] and MTAD, developed by Torabinejad et al in 2003, a mixture of doxycycline, citric acid, and a 0.5% polysorbate 80 detergent (Tween 80).[14] Each of these irrigation solutions has its own distinct properties and advantages. EDTA is an amino acid that chelates and lacks antimicrobial properties, removing the inorganic component of the smear layer while simultaneously leaving the organic matrix.[15] MTAD is a mixture of three components: doxycycline, citric acid, and a detergent. MTAD is designed to remove the smear layer without significantly altering the structure of dentinal tubules when canals are irrigated with sodium hypochlorite and MTAD.[16–20] It is bactericidal and has been shown to be effective in targeting *E. faecalis*.[3,21] It has also been shown to be biocompatible, nontoxic to tissues, and may enhance bond strength.[22,23]

Byström and Sundqvist[24] showed that there is no significant difference in antibacterial efficacy between different concentrations of sodium hypochlorite solutions and EDTA when used for endodontic irrigation. Johal et al[25] demonstrated that 5.25% NaOCl and 15% EDTA consistently disinfected infected root canals. However, the combination of 1.3% NaOCl/BioPure MTAD left nearly 50% of the canals contaminated with *E. faecalis*.

As new endodontic materials become available to clinicians, it is essential that the outcomes of cases using those new materials are assessed and tracked over time. Accumulated evidence of effectiveness of a material will serve as a guide for clinicians as they decide which irrigants to use in endodontics therapy. Currently, the literature is lacking long-term follow-up on cases using MTAD as a root canal irrigant. To address the gaps in the literature, this study evaluated cases where MTAD was used as a root canal irrigant over a period up to 19 years. The purpose of this study was to compare success rates of root canal treated teeth using MTAD or EDTA as root canal irrigant. The use of the periapical index (PAI), a standardized index used to determine the severity of a periapical lesion, was used for the purpose of evaluation. We hypothesized that the overall success rate between MTAD and EDTA cases would not be significantly different.

Materials and Methods

The Institutional Review Board approved this retrospective chart review (IRB #520380). Axium data access was requested from January 1, 2006, to October 15, 2022, for cases of completed root canal therapy performed in the Advanced Education Program of Endodontics at Loma Linda University School of Dentistry. Based on the chart review, 106 root canal cases were included. An inclusion criterion was root canal treatments, where either MTAD or EDTA irrigants were used solely in the treatment. Excluded cases were other irrigants and materials used in the treatment.

Of the 106 cases analyzed, 53 cases were treated using EDTA, and 53 were treated using MTAD. Both groups included cases with each of the different initial pulpal and periapical diagnoses. The three student researchers involved received extensive training and calibration in applying the PAI to each case using radiographic analysis before root canal therapy. PAI scores range from 1 to 5, where 1 is healthy periodontium radiographically, 2 is slight bony changes with no mineral loss, 3 is when there is some mineral loss, 4 is a well-defined radiolucency periapical lesion, and 5 is for large ill-defined radiolucency and severe periodontitis (►**Fig. 1**)[26–28]

After treatment completion, cases were randomly divided, and researchers were blinded and did not know whether cases had been endodontically treated using EDTA or MTAD. After the treatment and during follow-up visits, PAI scores were assigned to each case to quantitatively determine if sufficient healing had taken place. The radiographic images were reviewed and defined as a success or a failure, where success in root canal treatment was defined as a final PAI score of 1 or 2, while failure was defined as a PAI score of 3 to 5.

A chi-squared analysis was used to determine the difference in overall success rates between root canal cases using EDTA and MTAD. Additionally, a binomial logistic regression model was used to evaluate the success rate between the two different irrigants by follow-up year. The data analysis was performed with Jamovi with the α set at 0.05.

Observations and Results

There was no significant difference in outcomes between endodontic treatments performed using MTAD or EDTA ($r = 0.480$). ►**Fig. 2** illustrates similar success rates for both MTAD and EDTA, ~81 and 75%, respectively. Length of follow-up ranged from 1 to 17 years for the MTAD and 1 to 19 years for the EDTA group. There was no significant difference in success rate between cases treated with MTAD or EDTA over the follow-up years ($p = 0.235$). ►**Fig. 3** shows the number of cases treated with MTAD and EDTA for different follow-up years. Average length of follow-up among all cases was 7 years.

The majority of all cases evaluated had a final PAI of 1. ►**Fig. 4** illustrates the percentage of cases for each final

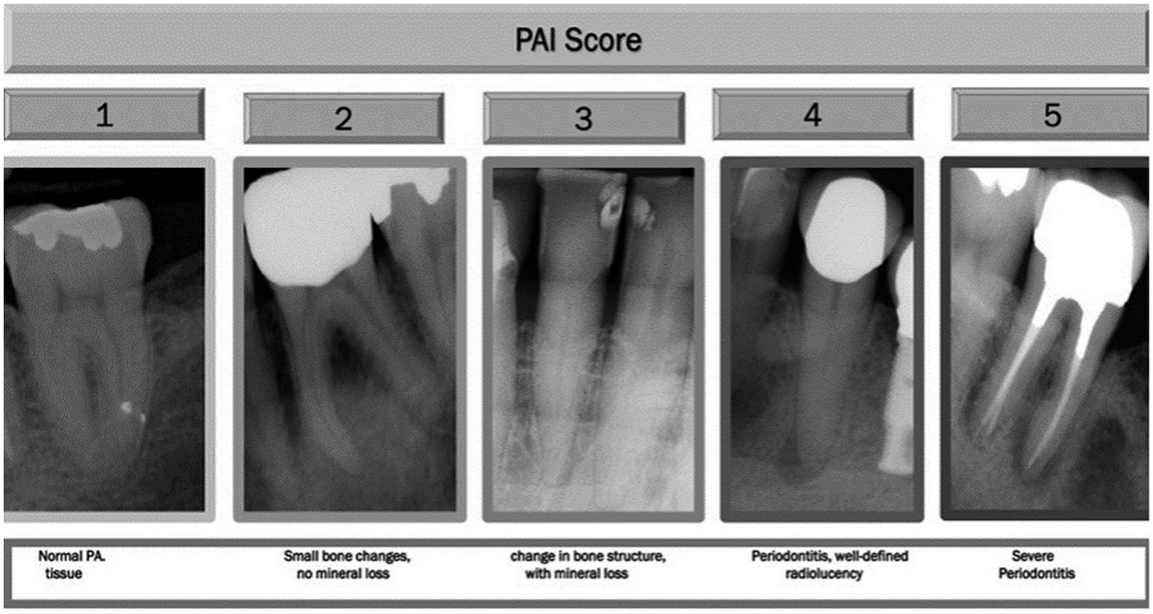

Fig. 1 Illustrations of periapical index (PAI) using study case radiographs.

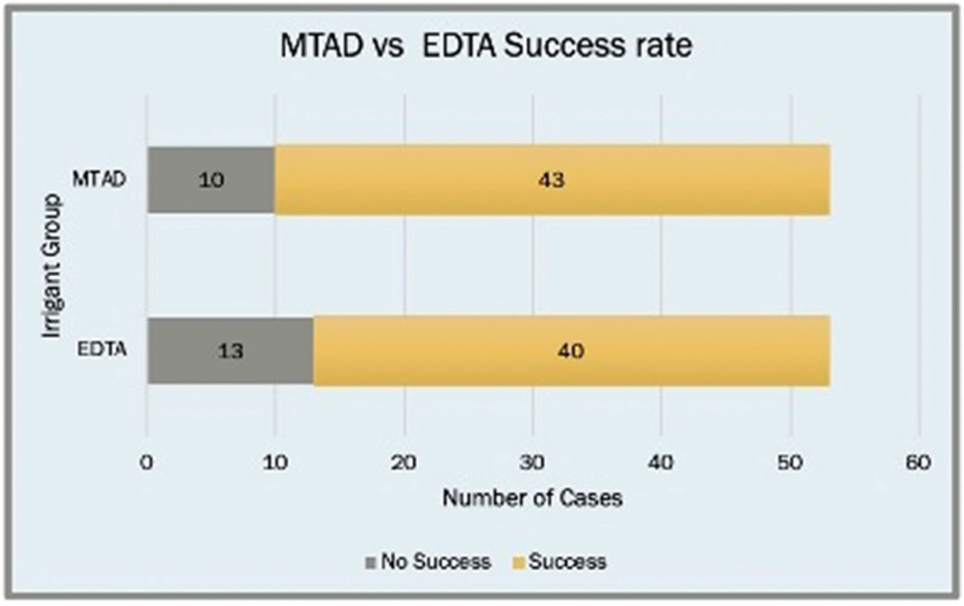

Fig. 2 Number of cases in MTAD and EDTA that were successful or unsuccessful at most recent follow-up. Success cases are represented in yellow, while failed cases are represented in gray with MTAD shown on top and EDTA on the bottom. EDTA, ethylenediaminetetraacetic acid; MTAD, mixture of doxycycline, citric acid, and a detergent.

PAI score, which is 78% for PAI scores of 1 and 2 in this study. A high success rate of root canal treatments was provided using MTAD as an irrigant followed up over a long period of time, 1 to 17 years. ►**Fig. 3** illustrates up to 17 years follow-up for MTAD and majority of cases were a success as illustrated in ►**Fig. 2**.

Discussion

There is a lack of dental literature analyzing the long-term effectiveness of MTAD as an irrigant in root canal cases. This study presents several cases that were analyzed up to 19 years postoperatively using MTAD as an irrigant solution and presents evidence based on a large sample size and multiple years of follow-up. There was no significant difference in outcomes between endodontic treatments performed using MTAD or EDTA in our study.

Similar results were found by Kho and Baumgartner in 2006, who in their study demonstrated that there was no difference in antimicrobial efficacy for irrigation with 5.25%

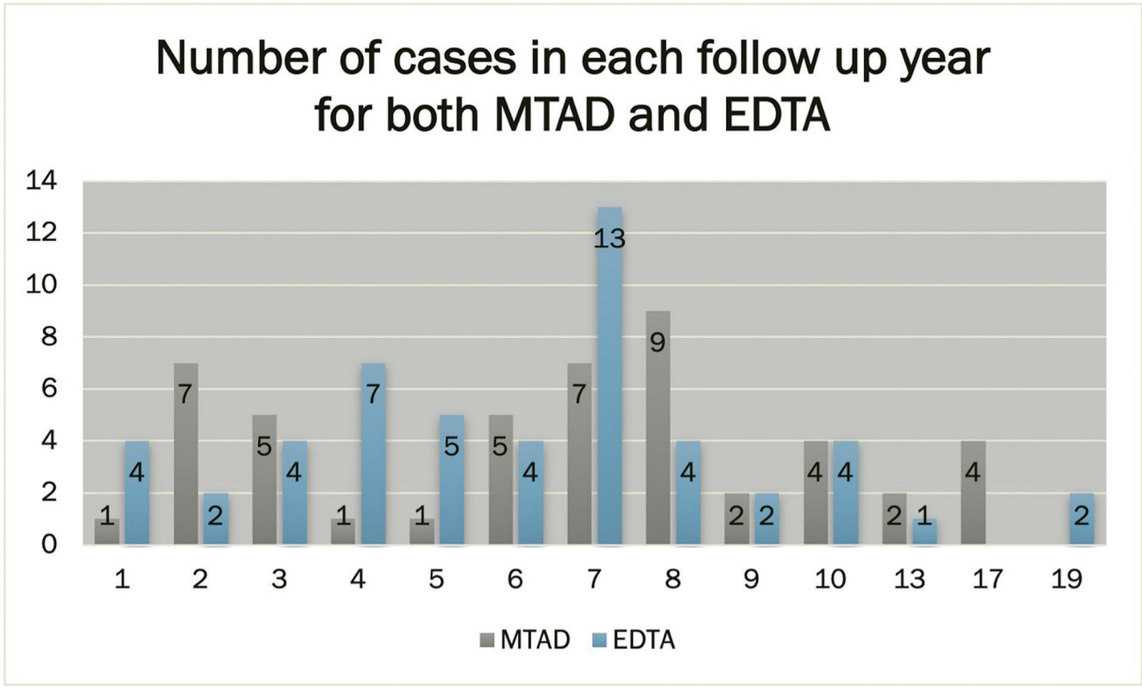

Fig. 3 Number of cases with each length of time (years) of total follow-up. Cases for MTAD and each follow-up year are represented in gray. EDTA cases for each follow-up year are represented in blue. EDTA, ethylenediaminetetraacetic acid; MTAD, mixture of doxycycline, citric acid, and a detergent.

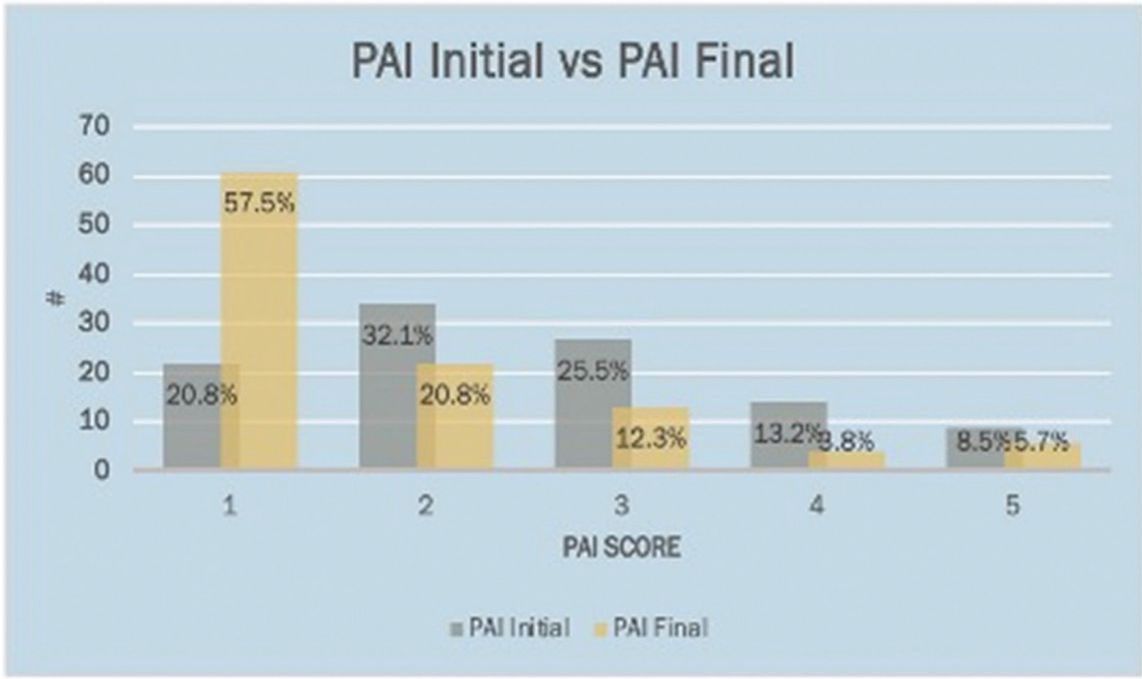

Fig. 4 Number and percentage of cases with each initial and final PAI scores. Percentage of cases for each final PAI score is shown in yellow, while percentage of cases for each initial PAI score is shown in gray. EDTA, ethylenediaminetetraacetic acid; MTAD, mixture of doxycycline, citric acid, and a detergent.

NaOCl/15% EDTA versus irrigation with 1.3% NaOCl/BioPure MTAD in the apical 5 mm of roots infected with *E. faecalis*.[29]

The results of our study are also similar to those of Lei et al (2015).[30] In their study, when endoactivator was applied for 30 seconds, viable counting of the 5.3% NaOCl/17% EDTA group and 1.3% NaOCl/MTAD group were lower than the MTAD group ($p < 0.05$), whereas the differences between the former two were not significant, implying the limited advantage of MTAD over the standard regime.

Although MTAD was specifically developed to improve treatment outcomes, the results suggest that MTAD and EDTA have similar effectiveness. This study adds long-term follow-up data on root canal treatments using MTAD as an irrigant. The results support the clinical effectiveness of MTAD, comparable to that of EDTA. Future research should continue to evaluate the long-term success of MTAD in root canal therapy, considering variables such as patient symptoms and quality of obturation.

Conclusion

MTAD demonstrates similar clinical effectiveness to EDTA when used as an irrigant in root canal therapy. The high success rates observed over extended follow-up periods highlight the efficacy of MTAD in endodontic treatments. Further research is indicated to further validate these findings.

Conflict of Interest
None declared.

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