

Obscure Fact of Ethylene Diamine TetraAcetic Acid (EDTA)

Abstract

Background

Chelating agents decalcify radicular dentin and eliminate the smear layer formed after the mechanical preparation of the root canal. Smear layer acts as a barrier that precludes irrigants from directly reaching and disinfecting the dentin surface, the dentinal tubules, and altering the sealing quality of obturation. Recently, chelators, such as phytic acid (PA) (inositol hexakisphosphate pH 1.3) and etidronic acid (1-hydroxyethane-1,1-diphosphonic acid [HEDP] pH 11), have been considered potential alternatives to EDTA. However, research has shown that the extended use of strong chelators as EDTA can have a detrimental effect on the biomechanical properties of root dentin, as evidenced by a drop in both microhardness and flexural strength.

Aim and Objective

The objective of this *in vitro* study was to examine the impact of different endodontic chelating agents on the flexural strength and micro hardness of root dentin.

Materials and Method

Forty dentin sticks were obtained from 10 single-rooted premolars and divided into four groups ($n = 10$). One stick from each tooth was assigned to one of the experimental groups and was soaked in one of the experimental chelating solutions for 10 min, and 15 min in 17% ethylenediaminetetraacetic acid (EDTA), 2.5% phytic acid (PA), 18% etidronic acid, or saline (control group). Following the 10 min, and 15 min soak, the sticks' flexural strength was evaluated using a 3-point loading test using the universal testing machine, and the surface microhardness was tested using a Vickers's microhardness tester.

Results: EDTA showed lower microhardness and flexure strength compared with the phytic acid and Etidronic acid.

Conclusion: Considering the limitations of this study, it can be concluded that both 2.5% Phytic acid and 18% etidronic acid chelators do not compromise the surface and bulk mechanical properties of radicular dentin

INTRODUCTION

- Endodontics always requires chemomechanical debridement, which causes the creation of a smear layer on root canal surfaces.¹

- The smear layer formed during mechanical instrumentation inhibits the effectiveness of irrigants, medicines, and root canal filling materials in dentinal tubules.²
- The smear layer created by mechanical instruments reduces the efficacy of irrigants, medications, and root canal filling materials in dentinal tubules.³
- EDTA (pH 8) is a reliable strong chelator that effectively removes smear layers.³
- Excessive usage of powerful chelators like EDTA might harm root dentin's biomechanical qualities, resulting in lower microhardness and flexural strength.³
- In an attempt to overcome the inadequacies of these solutions, some authors offer additional agents such as 7% maleic acid, 1% phytic acid, 0.2% chitosan, 6%MCJ (Morindacitrifolia juice), etidronic acid, 5% and 10% CaOCl₂, tea tree oil, 5% Tamarindus indica, and 5% green tea extract⁸
- Alternatives to EDTA include phytic acid (PA) and etidronic acid (1-hydroxyethane-1,1-diphosphonic acid [HEBP] pH 11).³
- Phytic acid (PA, inositol hexakisphosphate) is the primary phosphorus storage form found in plant seeds and bran, contributing to several cellular activities⁴
- Etidronate, an aqueous solution containing 1-hydroxyethylidene-1,1-bisphosphonate (HEBP), was developed in 2005 as an endodontic chelating agent.²

METHODOLOGY

Dentin sticks preparation

Ten sound single- rooted premolars extracted for orthodontic reasons were collected

Four radicular dentin sticks (1 mm × 1 mm × 12 mm) were obtained from each root using a precision diamond disk under copious water coolant.

One stick from each tooth was assigned to one of the four experimental irrigants.



Fig. 1. Dentin sticks preparation

Irrigant preparation

Four irrigant solutions were used for this study

Group 1 (control): saline

Group 2: 17% EDTA

Group 3: 2.5% PA

Group 4: 18% etidronate

Solutions were used as manufacture's instructions

Each stick was immersed separately in 1 mL of the irrigant solution in a sealed plastic tube and placed in an ultrasonic vibrator for 10 min and 15 min.

Then the stick was rinsed with saline, tested immediately.

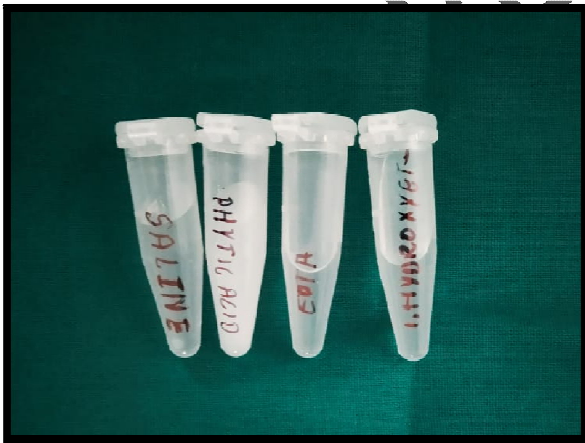


Fig. 2. Irrigant preparation

Statistical analysis

The numerical data were expressed in terms of mean and standard deviation values.

Homogeneity assumption was met in the surface hardness data so they were analyzed using one-way ANOVA followed by Tukey's *post hoc test*.

However, the assumption was violated in the flexural strength data so they were analyzed using Welch one-way ANOVA followed by Games-Howell *post hoc test*.

The significance level was set at $P < 0.001$ within all tests

Statistical analysis was performed with *R statistical analysis* software version 4.1.3 for Windows.

RESULTS AND DISCUSSION

Table 1. MEAN AND STANDARD DEVIATION VALUES FOR FLEXURAL STRENGTH (MPa) AND SURFACE MICROHARDNESS (VHN) AT 10 MINUTES

| | Control | ETAD | Etidronate | phytic acid | P |
|-------------------|-------------|-------------|--------------|--------------|--------|
| Flexural Strength | 197.91±2.92 | 71.26± 6.24 | 143.50 ±9.81 | 134.00 ±4.81 | <0.001 |
| Microhardness | 44.48± 6.26 | 30.16 ±1.27 | 33.15 ±0.58 | 33.18 ±2.26 | <0.001 |

Table 2. MEAN AND STANDARD DEVIATION VALUES FOR FLEXURAL STRENGTH (MPa) AND SURFACE MICROHARDNESS (VHN) AT 15 MINUTES

| | Control | ETAD | Etidronate | phytic acid | P |
|-------------------|---------------|-------------|---------------|--------------|--------|
| Flexural Strength | 124.62 ±11.95 | 50.61 ±0.72 | 117.25 ±14.66 | 112.83 ±5.43 | <0.001 |
| Microhardness | 38.38 ±0.28 | 27.77 ±0.71 | 31.52± 0.40 | 29.99 ±1.65 | <0.001 |

Fig. 3. GRAPHICAL REPRESENTATION OF FLEXURAL STRENGTH AT 10 MINUTES AND 15 MINUTES

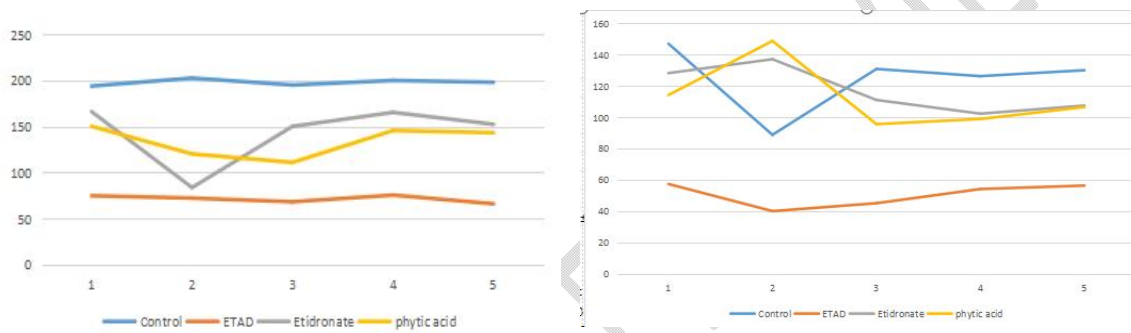
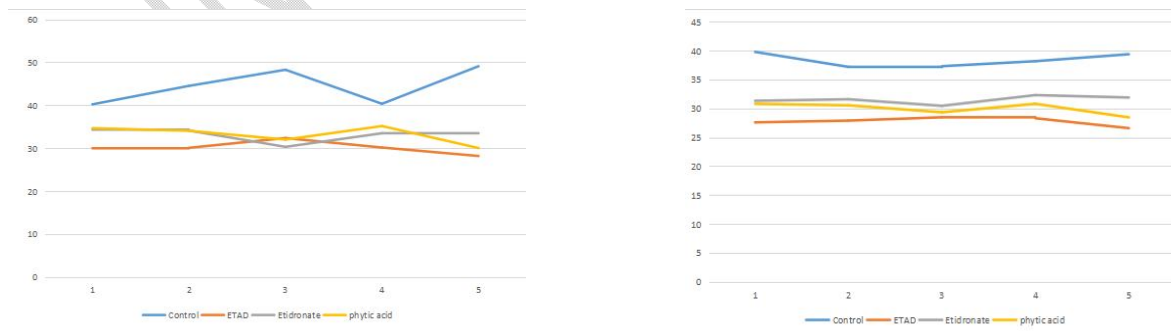


Fig. 4. GRAPHICAL REPRESENTATION OF MICROHARDNESS AT 10 MINUTES AND 15 MINUTES



- Root canal therapy requires the use of chelating substances. The biocompatibility and capacity to remove smear layers should be considered while selecting an irrigation solution.⁴
- The effectiveness depends on the concentration and contact time.³ Saline is not considered a good irrigation agent because of its poor performance in terms of dissolving organic and inorganic material²
- EDTA is the most commonly used chelator in root canal treatment. Using EDTA in conjunction with NaOCl in the absence of a distilled water dilution step may diminish the concentration of accessible chlorine content of NaOCl.²
- Higher EDTA dilutions significantly reduced cell viability and morphology⁴. So, 18% Etidronate combined with saline is advised.³ Phytic acid is beneficial in smear layer removal at a considerably lower concentration of 2.5% than EDTA, interpreting its biocompatibility.³
- Phytic acid solution at 1% concentration is more successful than EDTA for chelation and smear layer removal, while maintaining biocompatibility⁵
- The current study found that Flexural Strength of EDTA is 71.26 ± 6.24 at 10 minutes which reduced to 50.61 ± 0.72 at 15 minute.

Overall Flexural Strength of EDTA was considerably lower than untreated radicular dentin sticks, none of the tested irrigants, including PA and etidronate, significantly lowered the mechanical properties of dentin

- For EDTA, surface microhardness at 10 minutes showed 30.16 ± 1.27 which reduced to 27.77 ± 0.71 at 15 minutes.
- Following the EDTA administration on dentin sticks, the dentin surface microhardness was considerably decreased.
- Longer the exposure to higher concentration, the Flexural Strength and surface microhardness was reduced.

According to the findings of De-Deus et al. (2006)⁸ who claimed that the single use of 17% EDTA produced the greatest decrease in microhardness from reference state to 3 minutes, is in accordance with the present study.

Mukura Kulasekaran Dineshkumar et al. (2012)⁷ also concluded in his study -Effect of ethylene diamine tetra-acetic acid, MTADTM, and HEBP as a final rinse on the microhardness of root dentin that EDTA showed less microhardness compared with other solutions.

Effect of EDTA

EDTA's chelating activity effectively lowers dentinal microhardness. (The degree of mineral content and the amount of hydroxyapatite in the intertubular substance are important elements in determining the intrinsic hardness profile of dentin structure.⁶

Longer exposure to EDTA may promote dentine erosion and negatively impact the integrity of the dentine matrix.⁵

EDTA's removal of calcium ions (Ca^{2+}) from mineral tissues has been proven to degrade the dentin matrix. Calcium was depleted from the dentin surface to a depth of about $150\mu\text{m}$ after 2 hours of exposure to 17% EDTA.¹

EDTA has been linked to dentinal erosion due to its potential to demineralize root dentin when utilized over an extended period of time.¹

As a substitute

- To prevent erosion, use chelators with low concentrations and shorter chelating durations, such as phytic acid, etidronate, and chitosan.³
- HEBP-treated root dentin had the highest microhardness compared to the control group. This could be due to the increased intertubular dentin surface accessible for hybridization when a gentle chelating irrigation regimen including HEBP is used.⁷
- HEBP strengthened the binding between resin-based sealers and root canal dentin compared to EDTA.⁷

CONCLUSION

- Over the years, studies have focused mainly on assessing the influence of endodontic irrigating solutions and chemical agents used in adhesive dentistry on the chemical composition and mechanical properties of the coronal and root dentin.
- All tested chelators reduced microhardness of the human radicular Dentin, EDTA reduced the dentin microhardness more significantly than phytic acid.
- Considering the limitations of this study, it can be concluded that both 2.5% Phytic acid and 18% etidronic acid chelators do not compromise the surface and bulk mechanical properties of radicular dentin.

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