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Calcium loss on root canal dentin after Ethylenediaminetetraacetic acid (EDTA) application with different varians

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Abstract

Objective: This study aimed to compare calcium loss on root canal dentin before and after EDTA application with different varians and concentration with or without surfactant.

Material and Methods: Samples are mandibular premolar teeth single root canal, which is divided into 4 groups: Ethylenediaminetetraacetic Acid (EDTA) gel, cream, solution and negative control. They are decoronated in Cemento-Enamel Junction (CEJ), then prepared with Crown Down Pressureless (CDP) technique and separated buccolingual direction. One side was applied in EDTA according their respective groups and the other side was set as

sample before application. Samples before and after application of each group are destructed then subsequently measured for their Ca^{2+} 's amount using Atomic Absorption Spectrophotometry (AAS). Data were collected and analyzed using ANOVA and Tukey Post Hoc test.

Results: This showed significant differences between Ca^{2+} amount in root canal dentin before and after application either on EDTA gel, cream, or solution as well as on negative control group ($p < 0.05$).

Conclusion: Application of EDTA solution causes the highest calcium loss compared to EDTA gel and cream.

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Keywords: Calcium loss, EDTA, Root canal dentin

Cite This Article: Nugroho JJ, Rovani CA, Daharuddin H, Trilaksana AC, Natsir N, Sumidarti A. 2019. Calcium loss on root canal dentin after Ethylenediaminetetraacetic acid (EDTA) application with different varians. *Journal of Dentomaxillofacial Science* 4(2): 79-82. DOI: [10.15562/jdmfs.v4i2.781](https://doi.org/10.15562/jdmfs.v4i2.781)

Introduction

Success of root canal treatment depends on microorganism elimination in root canal and prevention of recurrent infections.¹⁻³ During the root canal instrumentation, chemicals are used as irrigant and lubricant to facilitate the movement of instrument inside root canal, so it reduce mechanical stress of root canal instrument and prevent fracture instrument in root canal.^{4,5}

Ethylenediaminetetraacetic acid (EDTA) is the most widely used lubricant in root canal treatment.⁶ EDTA help remove smear layer from root canal system mainly dominated by inorganic components.^{3,4} EDTA's capability in removing inorganic components influences chemical structure of root canal dentin. EDTA may cause a change in ratio of $\text{Ca}^{2+}:\text{PO}_4^{3-}$ in root canal dentin, which will then lead to microhardness decrease of root canal dentin. It may also affect strength of root canal sealer.⁵

Material and Methods

Samples that met the inclusion criteria was taken and decoronated on CEJ. Root canal preparation used ProTaper hand use (S1, Sx, S2, F1, F2-F5) and was irrigated with NaOCl 2.5% every turn of file. Samples was divided into 4 groups with 6 teeth for each. First group applied EDTA gel, second group

EDTA cream, third group EDTA liquid, and fourth group applied no-EDTA (negative control).

After samples was prepared, then it was separated longitudinally in buccolingual direction [figure 1](#). One side of sample would be applied with EDTA according to each group and the other side was set as sample prior to application. Except in negative control group, both sides were not applied with EDTA.

Samples was put into 110°C oven for 1 hour and then stored in desiccator for 15 minutes. They were inserted into 450°C furnace machine afterwards for 8 hours until it ashed. Then it was proceeded by wet destruction. It was dissolved with heated 10 ml of HCl 10M solution and then with HNO_3 0.1M solution to each sample until solution mixture reached 100 ml [figure 2](#). Sample that had turned into solution was filtered to further measure calcium amount by using AAS machine [figure 3](#).

Results

Based on Wilcoxon Signed Ranks test [table 1](#), all groups show value of $p=0.028$ ($p < 0.05$). It means that there are significant differences between Ca^{2+} amount in root canal dentin before and after EDTA application either on EDTA gel, cream, or solution as well as on negative control group.

Based on ANOVA test, it results value of $p=0.000$

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Received: 5 August 2018
Revised: 26 February 2019
Accepted: 28 February 2019
Available Online 1 August 2019



Figure 1 Samples are ready to be applied EDTA



Figure 2 Samples are dissolved with heated 10 ml of HCl 10M, then mixed with HNO₃ 0.1M until it reached 100 ml

Table 1 Difference in Ca²⁺ amount in root canal dentin before and after EDTA application based on respective EDTA variants

EDTA	N	Total Ca ²⁺ (mg/g) MEDIAN		p-Value
		Pre test		
Gel	6	216.736 (208.695 - 231.280)	209.474 (200.762 - 224.907)	.028*
	Cream	6	240.333 (207.017 - 299.686)	
Solvent	6	250.672 (210.104 - 288.920)	218.445 (180.711 - 257.106)	.028*
	Control	6	228.847	



Figure 3 AAS machine is reading the sample

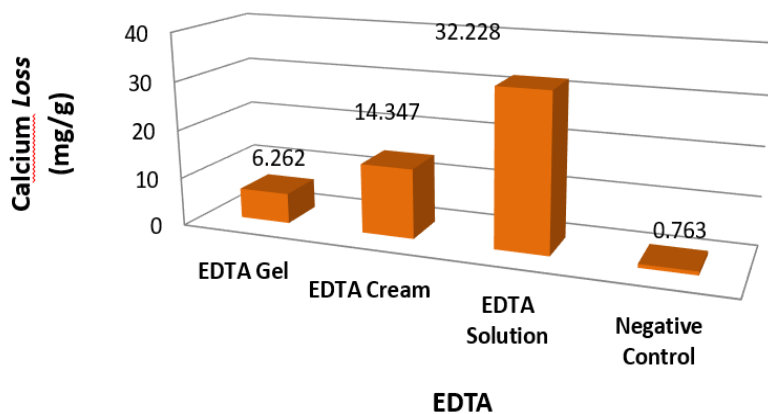


Figure 4 Calcium loss differences in each variant of EDTA. (private collection)

($p < 0.05$), where the highest calcium loss seen in group EDTA solution with mean value of 32.228 mg/g (figure 4). EDTA solution which was used in this study contained EDTA 17% added with surfactant benzalkonium bromide. Whereas both EDTA gel and cream contained EDTA 15% added with surfactant urea peroxide.

Discussion

In root canal dentin, EDTA reacts with Ca²⁺ in apatite crystals and causes dentin microstructure change through change in ratio of Ca²⁺:PO₄³⁻. EDTA's capability in causing decrease Ca²⁺ amount in root canal dentin was consistent EDTA 15% was able to reduce more Ca²⁺ amount than 10% citric acid.⁶

EDTA's capability to dissolve Ca²⁺ in root canal dentin showed in the number of smear layer removed at the time of instrumentation. This was in line with Kamakshi et al.⁷ concluded EDTA 17% was highly effective to remove smear layer.⁷ In accordance with the study, Qian et al.⁸ in root canal dentin smear layer concludes EDTA and citric acid had the ability to remove smear layer by the erosion effect on peritubular and intertubular root canal dentin.⁸ The erosion would then affect microhardness decrease of root canal dentin due to decomposition of root canal dentin components.^{8,9} EDTA in cream or pasta variant had a low flow-rate.^{10,11} This assuredly, would make it difficult for material to flow in narrow apical portion and to penetrate far into root canal dentin. As a result, chelation action by EDTA cream would be limited. Nevertheless, addition of surfactant urea peroxide in EDTA cream would help enhance effectiveness compared to EDTA gel although flow rate is slightly higher yet contains no surfactant.^{11,12}

Meanwhile, EDTA solution had the highest flow capacity so it could flow to apical end and penetrate deeper into dentin.^{10,12} This was in accordance with result of our study that calcium loss in EDTA solution was the highest.

EDTA 17% had ability to dissolve more Ca²⁺ than EDTA 15%, which was added with cationic surfactant 0.1%.¹³ In line with those, Handa et al.¹⁴ stated EDTA 17% is more effective in dissolving dentin-even approaching 70% mass of dentin.¹⁴ A research on smear layer and dentin erosion capacity caused by EDTA with various concentrations (15%, 10%, 5% and 1%). It is known that EDTA concentration affects the magnitude of value decrease Ca²⁺ amount in root canal dentin. On the other words, concentration of EDTA was

directly proportional to value of calcium loss.¹⁵

Conclusion

Based on our study, it can be concluded Ca^{2+} amount in root canal dentin before application decreases compared after application of EDTA gel, cream and solution; and application of EDTA solution causes the highest loss of Ca^{2+} compared to EDTA gel and cream. In clinical application, it is suggested EDTA selection is not based on simplicity of application but on variant that gives the lowest impact of calcium loss

Acknowledgment

In this study, we appreciate very much to Sarwo Edy, drg. and Irma Ariany Syam, drg. for assisting researcher in analyzing the data. And also Laboratory of Chemistry Faculty of Science and Technology, Islam Negeri University, for providing facilities required to accomplished this research work.

Conflict of Interest

The authors report no conflict of interest.

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