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The Effectiveness of Remineralizing Agents on Dentinal Permeability

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## Summary of the article

Marwah Berkathullah, Mohideen S. Farook, and Okba Mahmoud conducted a randomized controlled trial study of the effectiveness of remineralizing agents in the reduction of dentinal permeability by tubule occlusion. The data were measured and evaluated using a fluid filtration device at 100 cm H<sub>2</sub>O pressure and SEM/EDX analysis. The study was conducted at the Research Laboratory and Restorative Dentistry, University of Malaya and was published in BioMed Research International Journal on 12 September 2018 by Hindawi Publishing Corporation (<https://doi.org/10.1155/2018/4072815>).

Seventy (n=70) dentinal discs of 1±0.2 mm width were obtained from caries-free human molars. Fifty discs (n=50) were randomly selected and divided into 10 between 5 groups: GC Tooth Mousse Plus, Clinpro White Varnish, Duraphat Varnish, Colgate Sensitive Pro-Relief dentifrice, Biodentine. The data was gathered following application of remineralizing agents for 10 minutes, immersion into artificial saliva for 7 days, and citric acid challenge for 3 minutes. Twenty discs (n=20) were selected for SEM/EDX analysis to obtain morphological and elemental results.

The authors concluded that dentinal permeability was immediately reduced after application of remineralizing agents. Dentinal permeability was increased after immersion into artificial saliva for 7 days, except Clinpro White Varnish and Biodentine. Clinpro White Varnish also withstood citric acid challenge.

## Article information

The research article "The Effectiveness of Remineralizing Agents on Dentinal Permeability" was written by Marwah Berkathullah, Mohideen S. Farook, and Okba Mahmoud. The article was published on 12 September 2018 in BioMed Research International Journal (<https://www.hindawi.com/journals/bmri/>) by Hindawi Publishing Corporation (<https://doi.org/10.1155/2018/4072815>). The authors declare no conflict of interest in publishing this paper.

## Study analysis:

### 1. Type of study

The study type of the article is a randomized controlled trial. The study was conducted at the Research Laboratory and Restorative Dentistry, University of Malaya.

### 2. Study purpose

The study was conducted to compare the effectiveness of various remineralizing agents on dentinal permeability in order to reduce dentinal sensitivity by occluding dentinal tubules and reducing the fluid flow within the tubules to stop the transmission of the stimuli. As for today, the hydrodynamic theory is the most accepted, therefore it is imperative to research the proposed treatment of occluding the tubules and preventing the neurons from firing the pain signal. There are several recommended treatments and ingredients that claim to relieve dentinal hypersensitivity. Even though they work, the result is limited to the present time as the teeth are constantly susceptible to destruction by erosion and abrasion. The goal is to find the ingredients that will provide long-term insoluble precipitate within the dentinal tubules which can withstand the oral environment. Thus, the authors aimed to investigate the effectiveness and duration of the common products designed to reduce dentinal hypersensitivity in the artificial oral environment.

### **3. Experimental design**

The study was conducted to compare the effectiveness of various remineralizing agents on dentinal permeability by occluding dentinal tubules and reducing the fluid flow within the tubules utilizing a fluid filtration device working at 100 cm H<sub>2</sub>O (1.4 psi) pressure and SEM/EDX analysis.

Seventy (n=70) dentinal discs of 1±0.2 mm width were obtained from caries-free human molars extracted for medical reasons by cutting the teeth horizontally with a slow-speed sawing diamond disc under continuous water cooling. Each disc was treated with an acid etchant for maximum permeability and served as its own control.

Fifty discs (n=50) were randomly selected and divided into a sample of 10 (n=10) between 5 designated groups: GC Tooth Mousse Plus, Clinpro White Varnish, Duraphat Varnish, Colgate Sensitive Pro-Relief dentifrice, Biodentine. Firstly, dentine discs were evaluated for permeability, and a standard smear layer was created with silicon carbide abrasive grit paper. Next, acid etchant, 37% orthophosphoric acid was applied for 60 sec to enhance the permeability. Afterward, the remineralizing agents were applied for 10 minutes, and the values were obtained. The next measurements were collected after the immersion of the sample into artificial saliva for 7 days. Finally, the last values were obtained after the citric acid challenge for 3 minutes. The measurement of dentinal permeability was taken 3 times for 4 minutes using a calibrated ruler incremented in mm, and hydraulic conductivity related to dentinal permeability was measured by volume displacement.

Twenty discs (n=20) were randomly selected and distributed into a sample of 4 (n=4) between each group for the scanning electron microscope equipped with an energy X-ray dispersive spectrometer (SEM/EDX) analysis using the magnification 3500x. SEM/EDX was performed following 60 seconds of acid etching application, treatment

with remineralizing agents for 10 minutes, immersion into artificial saliva for 7 days, and citric acid challenge for 3 minutes for morphological, chemical, and elemental analysis. The researcher analyzed their findings statistically using SPSS version 20 for Windows. The researcher set all p-values at  $< 0.05$  and calculated the mean and standard deviation for all groups. The equality of variances for each group was checked using Levene's test. The researcher applied two-way repeated measures ANOVA. Bonferroni test was used as a post hoc analysis to evaluate statistically significant differences between groups. The research was calibrated by using a calibrated ruler incremented in mm.

## 4. Results

### *Permeability Measurement*

Each dentinal disc was treated with an acid etchant to create the maximum permeability and served as its own control. The subsequent application of the remineralizing agents resulted in a significant reduction of permeability compared to the control. However, the results were not statistically significant. The immersion of the samples into artificial saliva for 7 days showed increased mean permeability with the exception of Clinpro White Varnish. The citric acid challenge for 3 minutes showed increased permeability between all groups. Nonetheless, Clinpro White Varnish results were statistically significant in a citric acid challenge.

### *SEM/EDX Analysis*

The samples were subjected to SEM/EDX to collect morphological, elemental, and chemical analysis. Right after the acid etching challenge, the specimens exhibited exposed tubules and a decrease in minerals.

The first sample treated with GC Tooth Mousse Plus revealed uniformly covered dentinal tubules with few left open and high levels of Ca and P. The immersion in artificial saliva for 7 days partly removed the deposits, still exhibiting high Ca and P contents. The citric acid challenge removed even more deposits, rapidly reducing Ca and P levels.

The sample treated with Clinpro White Varnish revealed the occlusion of dentinal tubules and high levels of Ca and P. The immersion in artificial saliva for 7 days showed fewer blocked tubules with high levels of Ca and P. The citric acid challenge presented few exposed tubules with the same levels of Ca and P.

The sample treated with Duraphat Varnish showed the complete occlusion of the dentinal tubules with minimal levels of Ca and P. The immersion in artificial saliva for 7 days exhibited the significant opening of the tubules with low levels of Ca and P. The citric acid challenge presented the further opening of the tubules with low levels of minerals.

The sample treated with Colgate Sensitive Pro-Relief dentifrice revealed occluded dentinal tubules with only a few opened and high levels of Ca and P. The immersion in artificial saliva for 7 days changed the morphology and closed the tubules with high levels of Ca and P. The citric acid challenge removed the dentifrice and revealed intertubular dentin and high levels of Ca and P.

The sample treated with Biodentine revealed the complete occlusion of the dentinal tubules with few left open and high levels of Ca and P. The immersion in artificial saliva for 7 days showed a slight increase in the opening of the tubules and an increase in Ca level. The citric acid challenge presented the further opening of the tubules with the same level of Ca and the presence of Si.

## **5. Conclusions**

Based on the findings, the authors concluded that all remineralizing agents provided an initial reduction in dentine permeability after the application procedure. GC Tooth Mousse Plus showed poor results, so the researchers suggested that it requires several applications to form a layer of minerals to occlude dentinal tubules. Clinpro White Varnish exhibited excellent occlusion of the tubules, had great remineralizing potential, and withstood the citric acid challenge. Duraphat Varnish, one of the most used therapeutic agents, exhibited good initial results, subsequently failing saliva immersion and citric acid challenge. Studies show inconsistent results of the efficacy of sodium fluoride varnish, which is the main ingredient of Duraphat Varnish. While clinical studies showed the effectiveness of the agent, in vitro studies, including this one, proved its ineffectiveness. Colgate Sensitive Pro-Relief presented a dual mechanism in the decrease of sensitivity. The researchers concluded that arginine and calcium carbonate act together to form a precipitate that occludes tubules and react with saliva to emerge K and P to initiate remineralization. Moreover, the presence of K in the simulated oral environment and during citric acid indicates that K acts as a nerve stabilizer by inhibiting nerve excitation. Biodentine results were not significant compared to Clinpro White Varnish. The authors did not list questions for further investigation or any study limitations.

## **6. Your impression**

I believe this study is extremely important. Dentinal hypersensitivity is an issue for a lot of people across the world. It can make a person's life uncomfortable and limit daily activities and dietary choices. There are many products on the market that claim to reduce dentinal hypersensitivity. Unfortunately, some of them do not have proven active ingredients or are at a low percentage to fulfill their claims. Moreover, most current treatments reduce sensitivity only for the initial time after the applications and do not

provide a long-term effect. Therefore, the more research is done, the more information we will have about the agents with the research-proven ingredients.

I also think that this study is of great importance because it was performed in vitro. Therefore, it provides measurable results of the physical occlusion of the tubules. If the agents were applied to human participants, the data gathered from the participants is not as reliable because the perception of pain varies between people and can be biased.

The information from this study can help RDH provide in-the-office treatments that would last or educate patients on which efficient products to add to their homecare. I would like to learn more about the current methods of evaluation, identification, and management of dentinal hypersensitivity in clinical settings.

## References

- Berkathullah, M., Farook, M. S., & Mahmoud, O. (2018). The effectiveness of remineralizing agents on Dentinal Permeability. *BioMed Research International*, 2018, 1–12. <https://doi.org/10.1155/2018/4072815>