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# Investigation of Dentinal Tubule Occlusion by a Desensitizing Dentifrice: an in-Vitro Sem Analysis

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***Abstract: The purpose of this study was to compare patent dentin tubules to in vitro dentin tubules in order to assess the dentin tubule occluding impact of a dentifrice incorporating Pro-Argin Technology (Colgate Sensitive Plus). Methods: The diameter of the dentine tubule was measured using scanning electron microscopy (SEM) on 20 produced dentin discs that were either left untreated or treated with the dentifrice. To evaluate tubule patency, microphotographs were obtained at a 2000x magnification. The dentifrice covered the treated sample, filling the dentinal tubule and decreasing or closing the tubule opening, according to SEM imaging results. Conclusion: According to pertinent statistical analysis, Pro-argin technology efficiently blocked dentinal tubules, making it suitable for use as a dental anti-sensitivity agent.***

***Keywords: Desensitizing Agents, Dentin Tubules, Desensitizing Agents, and Dentine Sensitivity.***

## 1. INTRODUCTION

The term "dentinal hypersensitivity" (DH) refers to a type of discomfort that results from exposed dentin and is generally brought on by chemical, thermal, tactile, or osmotic stimuli and cannot be attributed to any other type of dental disease or defect.1,2 Patients' subjective experiences with DH pain might differ greatly from one patient to the next.3 3% to 88% of people have DH, which can cause varied degrees of discomfort when eating, drinking, or even breathing, according to Splieth and Tachou, et al. (2013).4,5 Having exposed dentine surfaces, open tubule orifices on the exposed dentine surface, and patent tubules leading to vital pulp are the three key diagnostic indicators of DH. Dentine exposure frequently results from the erosion of the cervical cementum, gingival recession, and erosion of the enamel brought on by various forms of tooth wear.6-8 the commonly recognized view of the

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mechanism underlying DH states that following stimulation, fluid is displaced inside the dentinal tubules, causing pain. Pain is caused by the activation of the nerve endings at the pulp-dentine interface caused by the movement of fluid inside and outside the tubules.9,10 The cause of dentine hypersensitivity and the characteristics of the lesion are currently only vaguely understood. The activation of pulpal mechanoreceptors is attributed to fluid movement inside exposed dentinal tubules, in accordance with the hydrodynamic hypothesis. Attrition resulting from occlusal discord, gingival recession following either a periodontal disease process or periodontal treatment, and trauma from tooth brushing are the most common causes of dentine exposure. For the treatment of hypersensitive dentine, a variety of chemicals have been explored thus far with varied degrees of effectiveness. The most popular treatments for reducing hypersensitivity include the use of iontophoresis, hard and soft tissue lasers, and dentifrices and mouthwashes containing desensitizing chemicals.11 Unfortunately, the methods used to cure this issue are ineffective and have no long-term consequences.12 This in-vitro SEM study's objective is to assess how well dentifrices containing pro-argin technology obstruct dentinal tubules to lessen dentinal hypersensitivity.
Resources and Procedures 20 maxillary first premolars that had just had orthodontic treatment were removed, cleaned, and kept in distilled water pending usage. The cementum layer was completely removed by scaling and root planing, revealing the dentine below. The cervical portion of the root was then prepped for a 2x2x1mm dentine disk utilizing a double diamond disk. The samples were then washed with distilled water after being treated with 17% ethylene-diamine-tetraacetic acid (EDTA) (Endo L, MAARC, Thane, Maharashtra, India) for 1 min to remove the smear layer. The samples were then split into two groups, each with ten samples: Control group in Group I; pro-argin group in Group II.

The diameter of untreated open dentine tubules in the control group served as the reference. The research group only received one application of the dentifrice, which was left on for two minutes and then washed off with distilled water. The samples were then fixed in ethanol solutions of increasing strength, dried, and gold-sputter coated in accordance with SEM specifications. Each specimen surface that was investigated using a SEM at magnifications of 500x, 1000x, and 2000x yielded photomicrographs. One researcher conducted a single blind analysis of the samples at a magnification of 2000x and determined the decrease in tubule diameter between the study group and the control group. The data for the control group's tubule diameter and the study group's tubule diameter decrease (measured in microns) were recorded on a data sheet. An unpaired t-test was then used to compare the two groups side by side, and the results were tallied.

**Observation and Results**

The mean tubule diameter for the control group was 1.97 ± 0.49 µm. Mean tubule diameter reduction achieved in the tooth-paste group was 0.83 ± 0.23µm (42.1 ± 11.8%). The unpaired t-test revealed extreme statistical difference in mean between the test and the control group ($p<0.0001$). Thus, the test sample showed significant reduction in the mean tubule diameter as compared to the control group (Table 1).

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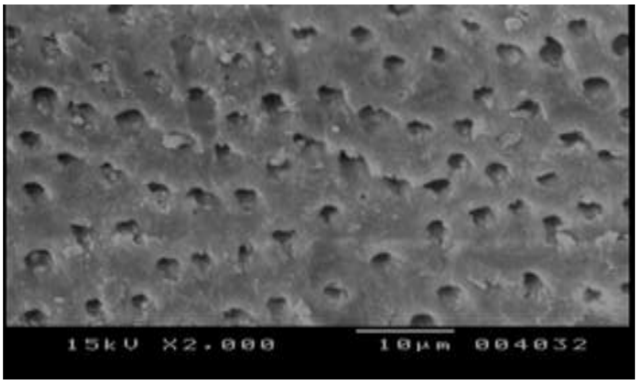

Fig.1 showing open dentinal tubules in control group under SEM 2000x magnification

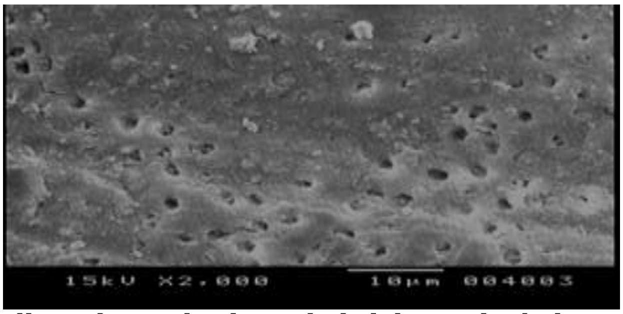

Fig.2 showing partially and completely occluded dentinal tubules in test group under SEM 2000x magnification. Reduction in dentine tubule diameter is calculated by measuring the diameter of the partially occluded tubules

Table1: showing dentinal tubule diameter reduction (in microns and in percentage) of the test group with reference to the control group

| | **Control Group (C)** | **Tooth-Paste Group (TP)** | |
|---|---|---|---|
| | Diameter Of Open Dentinal Tubule | Reduction Obtained (In Microns) | Reduction Obtained (In %) |
| **Mean** | 1.97 | 0.83 | 42.1 |
| **Standard Deviation (SD)** | 0.49 | 0.23 | 11.8 |

## 2. DISCUSSION

It is accurate to infer that people will have their natural dentition in the oral cavity for a longer length of time as life expectancy rises and thus DH will likely become more common. Concomitantly, new eating practices, such as regularly consuming acidic foods and drinks, can cause an increase in tooth wear and, as a result, dentin hypersensitivity.13 The body of research demonstrates that DH significantly lowers patients' quality of life.14 According to the Brännström and Aström hydrodynamic hypothesis, open dentinal tubules allow fluid to pass through them, stimulating the tooth pulp's nerve terminals. Scanning electron

 

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microscopy has revealed that tubules in clinically identified, "sensitive," exfoliated teeth are eight times more numerous, two times broader in diameter, and more permeable, in contrast to tubules in "non sensitive" teeth, which are less frequent, smaller, and typically plugged, as demonstrated in the research.15 Dentin hypersensitivity decreases when dentinal fluid flow declines, in accordance with the rules of hydrodynamics. 16 Desensitizers with neural or obliterating effect are two options for treating DH. Products having neurological action, such potassium nitrate, oxalates, and low-power laser treatment (photobiomodulation), aim to suppress neural activity, which causes depolarization of nerve fibers. Tubular occlusion can be treated with a variety of methods, including glutaraldehyde, varnishes, oxalates, bioglass, and high-power lasers.13 these therapeutic approaches can also be categorized as at-home, over-the-counter desensitizing mouthwashes, dentifrices, and professional treatments. Patients favor home use products the most because they are the most practical, reasonable, and routine solutions for mild to moderate DH. These are also acceptable due to their accessibility and simplicity of use when combined with regular oral hygiene practices like cleaning teeth.2 Frequently used desensitizing substances can also be divided into four groups: tubule-occluding substances (calcium hydroxide, potassium nitrate, sodium fluoride), protein precipitants (formaldehyde, silver nitrate, and strontium chloride hexahydrate), anti-inflammatory substances (corticosteroids), and resins and adhesives. None of these substances can, however, have long-lasting effects since DTs would eventually be exposed again due to DTs' abrasion and erosion by internal and external acids.17 Desensitizing mouthwashes and toothpastes work by precipitating crystals from their active components, which reduce dentinal tubule width.2 to treat this disease, there are several desensitizing toothpastes on the market right now. The majority of these products either block the exposed dentine tubules or desensitize the pulp nerve in order to function.18 With its unique pro-argin technology, the dentifrice Colgate Sensitive Plus utilized in this study is claimed to provide fast pain relief by constructing a calcium-rich coating that plugs the exposed dentine channels to shield sensitive teeth from unexpected shocks of pain. The open tubules are physically blocked and closed by the combination of arginine and calcium carbonate, according to early research, which results in desensitization of DH.19 Our findings also provide credence to the idea that arginine-rich toothpaste might reduce DH symptoms by shrinking the tubule diameter.18 The findings of this investigation are consistent with those of other studies using scanning electron microscopy that were conducted on tooth paste containing pro-argin by Petrou et al. in 200920, Cummins et al. in 201021, and Lavender et al. in 2010.

## 3. CONCLUSION

As a result of either lowering or blocking the exposed dentin tubules, the test dentifrice appears to be a useful tool for successfully treating dentine hypersensitivity, as shown by the results of the current investigation. To assess the long-term stability of the acquired favorable outcomes, more research is required, particularly long-term in-vitro and in-vivo investigations.

 

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