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A Scanning Electron Microscopic Study to Compare the Effect of Different Application Time of Desensitizing Agent on Dentinal Tubules

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ABSTRACT

Background: Dentin hypersensitivity is a common clinical condition caused by exposed dentinal tubules, leading to sharp, transient pain in response to external stimuli. Management involves tubule occlusion or neural modulation using agents like potassium salts, fluorides, oxalates, adhesives, and resin materials; hence, this study assessed the effect of different application times of desensitizing agents on dentinal tubules.

Materials & methods: This study evaluated the tubule-occluding ability and durability of Vivasens using 60 dentin specimens prepared from 30 extracted maxillary first premolars. After standardized cavity preparation, EDTA treatment, and SEM confirmation of open dentinal tubules, specimens were randomly allocated into four groups (Immediate, 5 min, 15 min, and 30 min) and treated per manufacturer's instructions. All samples underwent simulated brushing for one week and one month, followed by SEM analysis, with tubule occlusion graded by blinded observers to assess efficacy and long-term stability.

Results: The Immediate group demonstrated the highest mean score (10.32 ± 3.25), indicating maximum response at baseline. The 5 minutes group showed a reduced mean value of 5.99 ± 2.45, reflecting a significant decline compared to the immediate response. The 15 minutes group exhibited a further decrease with a mean of 2.36 ± 2.08, while the 30 minutes group recorded the lowest mean (0.89 ± 1.13), suggesting the greatest reduction over time. Overall, the findings indicate a progressive decline across groups, with the response diminishing steadily from the immediate period to 30 minutes.

Conclusion: Longer time is beneficial because the agents continue to act on the dentinal tubules with time, either by further precipitating within the tubules or forming a more stable barrier. This reduction in permeability translates into less fluid movement in the tubules, which reduces stimulation of nerve endings in the pulp — the key mechanism behind decreased sensitivity.

Keywords: *Sensitizing agent, Dentin hypersensitivity, Dentinal tubules*

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1. INTRODUCTION

Dentin hypersensitivity (DH) is a frequently encountered odontogenic disorder characterized by acute, transient nociceptive pain elicited from exposed dentin in response to thermal, mechanical, osmotic, or chemical stimuli. This clinical manifestation occurs when the protective enamel or cementum layer is compromised, resulting in exposure of dentinal tubules to the oral environment. Such exposure renders the dentin susceptible to external stimuli, thereby inducing discomfort and negatively impacting oral function and overall quality of life.[1, 2] The underlying pathophysiology of DH is attributed to the anatomical and structural properties of dentin, which is composed of mineralized tissue permeated by fluid-filled dentinal tubules that extend from the external dentin surface to the pulp chamber. These tubules are associated with odontoblastic processes, and stimulation leads to fluid displacement that activates pulpal nerve fibres. According to Brännström's hydrodynamic theory, the rapid fluid shifts within these exposed tubules represent the principal mechanism responsible for nociceptive transmission in DH. Etiological factors contributing to this condition include non-carious cervical lesions, erosive tooth wear, attrition, abrasion, and gingival recession, which collectively facilitate dentinal exposure.[3, 4] Therapeutic interventions for DH primarily target either the occlusion of exposed dentinal tubules or the modulation of neural excitability within pulpal A-delta fibres. Pharmacological agents such as potassium salts attenuate neural depolarization, whereas tubule-occluding materials reduce fluid dynamics within the dentin. Clinically employed desensitizing strategies include topical fluorides, oxalate-based agents, adhesive systems (self-etch and total-etch), composite resins, and resin-modified glass ionomer cements. These agents act by precipitating within or forming a superficial barrier over dentinal tubules, thereby mitigating fluid flow and effectively reducing hypersensitivity.[5, 6] Hence; the present study was conducted for assessing and comparing the effect of different application time of desensitizing agent on dentinal tubules

2. MATERIALS & METHODS

In this study, Vivasens was assessed for its ability to occlude dentinal tubules and its durability. A total of 60 specimens were prepared from 30 sound human maxillary first premolars extracted for orthodontic purposes and stored in 10% formalin. Teeth with caries, fractures, or malformations were excluded. Each tooth was sectioned mesiodistally to obtain 30 buccal and 30 lingual surfaces, which were embedded in plaster blocks, leaving the cervical areas exposed for cavity preparation. Cavities of standardized dimensions were created, and the resulting dentin blocks were polished to expose the surface. To ensure open dentinal tubules, specimens were treated with 17% EDTA for 40 minutes, ultrasonicated in distilled water, and then analyzed under scanning electron microscopy (SEM) to confirm tubule exposure before storage in artificial saliva. The specimens were randomly divided into four groups of 15 each based on time: Immediate group, 5 mins group, 15 mins group and 30 mins group. Treatments were applied according to manufacturer instructions and analyzed under SEM for initial tubule occlusion. All specimens were then subjected to simulated brushing twice daily for one week and one month, with interim storage in artificial saliva. Post-brushing SEM analysis was performed to assess the durability of occlusion. Tubule occlusion was graded by blinded observers using a standardized scoring system: Occluded (100% of tubules occluded); Mostly occluded (50% to <100% of tubules occluded); Partially occluded (25% to <50% of tubules occluded); Mostly unoccluded (<25% of tubules occluded); and Unoccluded (0%, no tubule occlusion). Mean scores from both observers were used for final analysis, enabling evaluation of the comparative occluding ability and long-term effectiveness of the desensitizing agent.

3. RESULTS

A total of 60 specimens were included. The specimens were randomly divided into four groups of 15 each based on time: Immediate group, 5 mins group, 15 mins group and 30 mins group. Table 1 presents the comparative analysis of four groups based on their mean values and standard deviations. The Immediate group demonstrated the highest mean score (10.32 ± 3.25), indicating maximum response at baseline. The 5 minutes group showed a reduced mean value of 5.99 ± 2.45, reflecting a significant decline compared to the immediate response. The 15 minutes group exhibited a further decrease with a mean of 2.36 ± 2.08, while the 30 minutes group recorded the lowest mean (0.89 ± 1.13), suggesting the greatest reduction over time. Overall, the findings indicate a progressive decline across groups, with the response diminishing steadily from the immediate period to 30 minutes.

Table 1: Comparison of Groups

Groups	Valid N	Mean	Std. dev.
Immediate group	15	10.32	3.25
5 mins group	15	5.99	2.45
15 mins group	15	2.36	2.08
30 mins group	15	0.89	1.13

4. DISCUSSION

Dentinal hypersensitivity (DH) is one of the most common causes of dental pain encountered in clinical practice. This condition is particularly prevalent at the dentino-enamel junction (DEJ) of the buccal cervical region due to extensive dentinal tubular branching, with the highest incidence reported between the second and fourth decades of life. DH is defined as a transient, sharp pain of sudden onset that cannot be attributed to any other dental pathology. It is most often triggered by cold stimuli and may be exacerbated by mechanical forces such as tooth brushing.[7] Several clinical strategies are employed for the management of DH, including application of ions/salts, iontophoresis with fluoride, dentin sealants, laser therapy, and periodontal soft tissue grafting. Currently, two principal therapeutic and preventive approaches are recognized: nerve conduction blockade and dentinal tubule occlusion. Potassium salts are used in the former approach, inducing depolarization of pulpal nerve fibers to disrupt nerve transmission. The latter involves physical or chemical occlusion of the dentinal tubules, reducing fluid movement within the tubules and thereby diminishing pulpal sensory stimulation.[8- 10] Hence; the present study was conducted for assessing and comparing the effect of different application time of desensitizing agent on dentinal tubules

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5. CONCLUSION

Longer time is beneficial because the agents continue to act on the dentinal tubules with time, either by further precipitating within the tubules or forming a more stable barrier. This reduction in permeability translates into less fluid movement in the tubules, which reduces stimulation of nerve endings in the pulp — the key mechanism behind decreased sensitivity.

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