ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Vol 11, Issue 11, November 2024

Efficacy of Biosilicate Glass-ceramic and Fluoride Varnish in the Treatment of Dentin Hypersensitivity

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Abstract— Background: *This study was conducted to assess the Efficacy of Biosilicate Glass-ceramic and Fluoride Varnish in the Treatment of Dentin Hypersensitivity.*

Material and methods: *This study was conducted to assess the effectiveness of Biosilicate Glass Ceramic and Fluoride Varnish in the treatment of dentin hypersensitivity (DH). The study comprised of 50 subjects reporting with dentine hypersensitivity (DH). The subjects had been explained the procedure and were asked to provide consent. The subjects who agreed to provide consent had been included in the study. The subjects belonged to the age group of 20-40 years with the mean age of 27.8 years. The subjects had been divided into 2 groups based on the treatment. Group 1 comprised of 25 subjects whose teeth were treated with Biosilicate Glass Ceramic and group 2 comprised of the remaining 25 subjects whose teeth had been treated with Duraphat Varnish. A visual analogue scale (VAS) was used to assess the level of pain, using volatile and tactile tests. Each product was randomly applied on one tooth per participant once a week for 4 weeks and evaluated every 15 days for 60 days after the last application. Statistical analysis was conducted using SPSS software.*

Results: *In this study, 11 (22%) subjects belonged to the age group of 20-25 years, 32 (64%) subjects belonged to the age group of 26-30 years, 5 (10%) subjects belonged to the age group of 31-35 years and 2 (4%) subjects belonged to the age group of 36-40 years Group 1 comprised of 25 subjects whose teeth were treated with Biosilicate Glass Ceramic while Group 2 comprised of 25 subjects who had been treated using Duraphat Varnish. The average Visual Analog Scale (VAS) scores recorded during the preliminary assessment of volatile sensitivity were 6.95±3.25 for the Biosilicate group and 6.74±3.19 for the Duraphat group. By the fourth week, these scores decreased to 0.53±1.1 for Biosilicate and 0.67±1.8 for Duraphat. After a period of 60 days, the volatile sensitivity values were noted as 0.87±1.9 for the Biosilicate group and 1.01±1.3 for the Duraphat group. Initial tactile sensitivity measurements were 1.56±2.94 for Biosilicate and 1.47±2.58 for Duraphat. At the 60-day follow-up, tactile sensitivity scores were recorded as 0.26±0.68 for Biosilicate and 0.11±0.27 for Duraphat, indicating a statistically significant difference.*

Conclusion: *The findings of this research demonstrated that both products effectively facilitated a significant decrease in dentin hypersensitivity, yielding comparable outcomes over a 60-day observation period.*

Index Terms: *Duraphat, Biosilicate, Ceramic, Dentine Hypersensitivity.*

I. INTRODUCTION

Dentin hypersensitivity can be defined as a short, sharp pain arising when dentin is exposed to evaporative, thermal, tactile, osmotic or chemical stimuli and the pain cannot be ascribed to any other dental defect or disease.[1,2] Dentin hypersensitivity is believed to be activated by fluid flow within dentin tubules resulting from changes in temperature or from physical or osmotic stimuli near an exposed dentin surface. Patients report pain as being triggered principally by cold drinks but also by hot drinks, toothbrushing and sweet foods. Fluid flow purportedly excites baroreceptors, leading to neural discharge—the so-called hydrodynamic theory of pain.[3,4]

The hydrodynamic theory assumes that tubules are patent between the exposed dentin surface and the pulp. Dentin tubules may become exposed as a result of enamel loss from attrition, abrasion, erosion (acid dissolution) or abfraction (cervical stress lesion); however, dentin exposure most often results from gingival recession accompanied by cementum loss from the root surfaces of canines and premolars.[5,6]

Bioactive glasses exhibit notable bioactivity, but their mechanical properties are low.[7] Thus, bioactive glass ceramics were developed to improve their mechanical properties. However, as their crystalline volume increases, the rate of apatite formation in vitro decreases significantly. The crystallization of these glasses renders them inert materials. Biosilicate® is a bioactive glass ceramic that achieves high crystallinity and mechanical properties through controlled crystallization while maintaining its bioactivity.[8] Biosilicate® is a bioactive glass ceramic composed of 23.75% Na_2O, 23.75% CaO, 48.5% SiO_2, and 4% P_2O_5. It is available in two forms: BS-1P, which has one crystalline phase of sodium calcium silicate ($Na_2CaSi_2O_6$), and BS-2P, which has two crystalline phases, $Na_2CaSi_2O_6$ and sodium calcium phosphate ($NaCaPO_4$).[9]

Fluoride prevention and control of tooth hypersensitivity and dentin as well as bleaching hypersensitivity can modestly be realized by using toothpaste with concentration between 1,000 and 1,500 ppm F as NaF, MFP, or AmF. Fluoride and different combinations of agents with occluding properties of

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Vol 11, Issue 11, November 2024

the dentin tubules such as metal ions, silica and nitrate, and oxalates may improve this effect. Toothpaste with stannous fluoride show somewhat better effect but show disadvantages with discolorations of teeth. The recent data with fluoride toothpaste plus argine (Pro-Arg Technique) are promising without obvious clinical disadvantages.[10]

This study was conducted to assess the Efficacy of Biosilicate Glass-ceramic and Fluoride Varnish in the Treatment of Dentin Hypersensitivity.

II. MATERIAL AND METHODS

This study was conducted to assess the effectiveness of Biosilicate Glass Ceramic and Fluoride Varnish in the treatment of dentin hypersensitivity (DH). The study comprised of 50 subjects reporting with dentine hypersensitivity (DH). The subjects had been explained the procedure and were asked to provide consent. The subjects who agreed to provide consent had been included in the study. The subjects belonged to the age group of 20-40 years with the mean age of 27.8 years. The subjects had been divided into 2 groups based on the treatment. Group 1 comprised of 25 subjects whose teeth were treated with Biosilicate Glass Ceramic and group 2 comprised of the remaining 25 subjects whose teeth had been treated with Duraphat Varnish. A visual analogue scale (VAS) was used to assess the level of pain, using volatile and tactile tests. Each product was randomly applied on one tooth per participant once a week for 4 weeks and evaluated every 15 days for 60 days after the last application. Statistical analysis was conducted using SPSS software.

III. RESULTS

Table I: Age-wise distribution of subjects

Age group	Number of subjects	Percentage
20-25 years	11	22
26-30 years	32	64
31-35 years	05	10
36-40 years	02	04
Total	50	100

In this study, 11 (22%) subjects belonged to the age group of 20-25 years, 32 (64%) subjects belonged to the age group of 26-30 years, 5 (10%) subjects belonged to the age group of 31-35 years and 2 (4%) subjects belonged to the age group of 36-40 years.

Table II: Group-wise distribution of subjects

Group	Number of subjects	Percentage
Group 1 (Biosilicate)	25	50
Group 2 (Duraphat)	25	50
Total	50	100

Group 1 comprised of 25 subjects whose teeth were treated with Biosilicate Glass Ceramic while Group 2 comprised of 25 subjects who had been treated using Duraphat Varnish.

Table III: Volatile sensitivity before treatment, after 4th week of treatment and at 60 days after treatment.

Groups	Initial sensitivity	At 4th week of treatment	60 days after treatment
Biosilicate	6.95±3.25	0.53±1.1	0.87±1.9
Duraphat	6.74±3.19	0.67±1.8	1.01±1.3

The average Visual Analog Scale (VAS) scores recorded during the preliminary assessment of volatile sensitivity were 6.95±3.25 for the Biosilicate group and 6.74±3.19 for the Duraphat group. By the fourth week, these scores decreased to 0.53±1.1 for Biosilicate and 0.67±1.8 for Duraphat. After a period of 60 days, the volatile sensitivity values were noted as 0.87±1.9 for the Biosilicate group and 1.01±1.3 for the Duraphat group.

Table IV: Tactile sensitivity before treatment and 60 days after treatment.

Groups	Initial sensitivity	60 days after treatment
Biosilicate	1.56±2.94	0.26±0.68
Duraphat	1.47±2.58	0.11±0.27

Initial tactile sensitivity measurements were 1.56±2.94 for Biosilicate and 1.47±2.58 for Duraphat. At the 60-day follow-up, tactile sensitivity scores were recorded as 0.26±0.68 for Biosilicate and 0.11±0.27 for Duraphat, indicating a statistically significant difference.

IV. DISCUSSION

Dentin hypersensitivity (DHS) is one of the most common complaints from patients in dental clinics. DHS has been defined as a short, sharp pain that arises from exposed dentin in response to non-noxious stimuli, typically thermal, evaporative, tactile, osmotic or chemical, and that cannot be ascribed to any other form of dental defects or diseases.[11] Studies have demonstrated vast variations in the prevalence of DHS, ranging from 1 to 98%.[12]

In patients with DHS, the affected teeth become sensitive to generally non-harmful environmental stimuli. Gentle touch, mild cold or hot, chemical (acidic or sweet fruits, foods, drinks) and air-flow stimuli can induce short sharp pain that may affect daily activities including eating, drinking, speaking and tooth brushing. More severe DHS can last more than 6 months and become a consistent annoyance, inducing psychological and emotional distractions[13,14], which may trigger the development of chronic dental pain condition

requiring management as neuropathic pain. It is also known that the oral health related quality of life in patients with DHS can be improved after DHS has been treated successfully.[15]

A fully crystallized bioactive glass-ceramic (P_2O_5-Na_2O-CaO-SiO_2) named Biosilicate, which has been developed by a multidisciplinary research group, has been proposed to treat DH by hydroxyl carbonate apatite (HCA) deposition in open dentinal tubules.[16] Bioactive glasses and glass-ceramics are widely recognized as one of the best clinical choices to improve bone regeneration,[17] and the similarity of composition between bone, dentin and enamel led to the assumption that bioactive glasses and glass-ceramics could also be efficient for the regeneration of enamel and dentin. Indeed, the hypothesis was that glass-ceramics could treat DH by providing permanent occlusion of the open dentinal tubules through *in situ* deposition of a HCA-bonded layer.[18,19]

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Tirapelli C et al (2010).[20] Dentin hypersensitivity (DH) is a painful response to stimulus applied to the open dentinal tubules of a vital tooth. It's a common oral condition, however, without an ideal treatment available yet. This work evaluated in vitro the effect of micron-sized particles from a novel bioactive glass-ceramic (Biosilicate) in occluding open dentinal tubules. A dentin disc model was employed to observe comparatively, using scanning electron microscopy (SEM), dentinal tubule occlusion by different products and deposition of hydroxyl carbonate apatite (HCA) on dentin surface by Biosilicate, after a single application: G1 - Dentifrice with potassium nitrate and fluoride; G2 - Two-step calcium phosphate precipitation treatment; G3 - Water-free gel containing Biosilicate particles (1%); G4 - Biosilicate particles mixed with distilled water in a 1:10 ratio; all of them after 1, 12 and 24 hours of immersion in artificial saliva. Fourier transform infrared spectroscopy (FTIR) was performed to detect HCA formation on dentin discs filled with Biosilicate after 2 minutes, 30 minutes and 12 hours of immersion in artificial saliva. SEM showed a layer of HCA formed on dentin surface after 24 hours by G4. G1, G2 and G3 promoted not total occlusion of open dentinal tubules after 24 hours. FTIR showed HCA precipitation on the dentin surface induced by Biosilicate after 30 minutes. The micron-sized particles from the bioactive glass-ceramic thus were able to induce HCA deposition in open dentinal tubules in vitro. This finding suggests that Biosilicate may provide a new option for treating DH.

Petersson LG et al (2013)[21] brought light on fluoride to control dentin hypersensitivity (DHS) and prevent root caries. Search strategy included papers mainly published in PubMed, Medline from October 2000 to October 2011. Fluoride toothpaste shows a fair effect on sensitive teeth when combined with dentin fluid-obstructing agents such as different metal ions, potassium, and oxalates. Fluoride in solution, gel, and varnish give an instant and long-term relief of dentin and bleaching hypersensitivity. Combined with laser technology, a limited additional positive effect is achieved. Prevention of root caries is favored by toothpaste with 5,000 ppm F and by fluoride rinsing with 0.025–0.1 % F solutions, as the application of fluoride gel or fluoride varnish three to four times a year. Fluoride measures with tablets, chewing gum, toothpick, and flossing may be questioned because of unfavorable cost effectiveness ratio. Most fluoride preparations in combination with dentin fluid obstruction agents are beneficial to reduce DHS. Prevention of root caries is favorable with higher fluoride concentrations in, e.g., toothpaste. Fluoride is an effective agent to control DHS and to prevent root caries particularly when used in higher concentrations.

Roriz VM et al (2024)[22] compared the efficacy of Biosilicate and Duraphat in the treatment of dentin hypersensitivity (DH). This clinical trial was conducted with young adults presenting DH. A visual analogue scale (VAS) was used to assess the level of pain, using volatile and tactile tests. Forty participants presenting two teeth with DH were included, and these teeth were divided into two groups according to the treatment: Biosilicate or Duraphat. Each product was randomly applied on one tooth per participant once a week for 4 weeks and evaluated every 15 days for 60 days after the last application. The mean and standard deviation (SD) of VAS values for the initial volatile sensitivity evaluation were 6.18 (1.99) and 6.08 (1.98) for the Biosilicate and Duraphat groups, respectively, and at the fourth week 0.48 (1.5) and 0.83 (1.58). After 60 days, the volatile sensitivity showed the following values: 0.63 (1.19) for Biosilicate and 1.03 (1.07) for Duraphat. The intragroup comparison showed a significant reduction of mean VAS

values for DH-related pain assessed by volatile testing for both groups ($p<0.001$), and the assessment at the 60-day follow-up showed mean values statistically similar to those obtained at the end of treatment. Initial tactile sensitivity observed was 1.48 (2.39) for the Biosilicate and 1.4 (2.2) for the Duraphat group and at the 60-day follow-up 0.23 (0.73) and 0.15 (0.36), respectively, with significant statistical difference ($p<0.002$). When the reduction in tactile and volatile sensitivities between both groups was compared, no statistically significant difference was observed. This study indicated that both products were able to promote an important reduction in dentin hypersensitivity with similar results within a 60-day follow-up.

V. CONCLUSION

The findings of this research demonstrated that both products effectively facilitated a significant decrease in dentin hypersensitivity, yielding comparable outcomes over a 60-day observation period.

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