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Dentin Hypersensitivity: A Randomized Clinical Comparison of Three Different Agents in a Short-term Treatment Period

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Clinical Relevance

The three tested desensitizing agents were equally effective in relieving dentin hypersensitivity and showed statistically significant pain reduction when compared to a placebo.

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SUMMARY

Objective: Dentin hypersensitivity, or what patients may describe as "sensitive teeth," is defined as a short, sharp pain arising from exposed dentin in response to thermal, evaporative, tactile, electrical, osmotic or chemical stimuli. It is widely accepted that dentin hypersensitivity is an uncomfortable condition that also affects function and quality of life. This study determines the differences in efficiency of three desensitizing products when compared with a placebo.

Methods: A randomized controlled clinical trial was conducted to compare three different professional dentin desensitizer agents in 52 patients. The age and sex of the patients was recorded. Gluma Desensitizer (Heraeus Kulzer), UltraEZ (Ultradent Products, Inc) and Duraphat (Colgate Oral Pharmaceuticals, Inc, New York, NY, USA) were used as desensitizer agents and

distilled water was used as the placebo. The baseline measurement of the dentin hypersensitivity was made by using a visual analog scale (VAS). Twenty-four hours and seven days after application of the desensitizer agents and placebo, a new VAS analysis was conducted for patients' sensitivity level. The desensitizer agents were compared in terms of mean values, and ANOVA was used for testing differences among the groups ($p<0.05$).

Results: The results showed that the mean pain scores of the placebo group were significantly higher than that of the study groups ($p<0.05$). The VAS analysis revealed a significant decrease in dentin hypersensitivity over time with the use of agents ($p<0.05$). No statistically significant difference was found among the three desensitizing agents ($p>0.05$).

Conclusions: These three desensitizing agents, which contain different active ingredients, were effective in relieving dentin hypersensitivity. However, no superiority was found in dentin sensitivity relief among the agents.

INTRODUCTION

The condition "dentin hypersensitivity," which generally involves the facial surfaces of teeth near the cervical border, is very common in premolars and canines. Although sensitivity affects all ages, previous studies showed that there is a strong correlation between age and dentinal hypersensitivity. It was reported that dentin hypersensitivity was frequently seen between the ages of 20 and 50, but especially between the ages of 20 and 30.[1] Moreover, dentin hypersensitivity is reported more frequently in women than in men.[2] The calcium precipitation on the surface of the tooth is one of the natural occluders of dentin tubules. Preventing calculus formation by using toothpaste or removing calculus on the surface of the tooth by professionals can reveal dentin hypersensitivity.[3] Moreover, dentin hypersensitivity is a common side effect of tooth whitening procedures.[4] Haywood stated that 55%-75% of patients suffered from this whitening-related sensitivity.[5]

Dentin may become exposed by several means. The most common clinical cause of exposed dentinal tubules is gingival recession. The more bone loss that occurs, the more dentinal tubules are exposed, which results in more dental hypersensitivity.[3] Brushing habits, diet, chewing tobacco and some diseases, including gastroesophageal reflux, can also cause dentin hypersensitivity. Extremely hard brushing, especially with harder-bristled brushes, is known to thin enamel and cause the gingiva to recede, exposing the softer subgingival cementum.[6] Right-handed people tend to brush the left side of their teeth more zealously, which results in hypersensitivity in those teeth.[7-8] Also, abfraction, which is the microstructural loss of tooth substance in areas of stress concentration, can lead to hypersensitivity. This occurs most commonly in the cervical region of teeth, where flexure may lead to a breaking away of the extremely thin layer of enamel rods, as well as microfracture of the cementum and dentin.[9] Besides, habitual ingestion of acidic substances causes erosion of enamel and dentin, subsequently opening the dentinal tubules.[7-8] They effectively strip away the tooth's protective smear layer, which contains dead organic material that occludes the dentinal tubules, preventing the outward flow of tubular solution.[4,7-8]

There are several theories for dentinal hypersensitivity, such as odontoblastic transduction theory, neural theory and hydrodynamic theory.[3] The most widely accepted theory for dentinal hypersensitivity is the hydrodynamic theory presented by Brannstrom and others,[10] which suggests that the fluids within the dentin tubules flow due to the thermal, mechanical, vaporative and osmotic stimuli. The flow of liquids in dentinal tubules can trigger nerves along the pulpal canal of the dentin, causing pain. This hydrodynamic flow can be increased by hot, cold, sweet or sour beverages, cold air, aggressive flossing and brushing.[3,10-15]

There are two principal treatment options. These are plugging the dentinal tubules, preventing fluid flow and desensitizing the nerve, making it less responsive to stimulation. Several approaches and numerous agents have been investigated for treating dentinal hypersensitivity, including corticosteroids, silver nitrate, zinc and strontium chloride, formaldehyde, glutaraldehyde, calcium hydroxide, sodium citrate, potassium oxalate, resin adhesives and fluorides.[4,15-18]

West,[19] in a recent review, hinted that conclusive evidence of successful treatment regimens of dentin hypersensitivity remains elusive, despite a multitude of products available for treatment. The efficacies of these products are varied, not well-established and unpredictable; therefore, clinicians are left to determine the most satisfactory and effective treatment approach for the relief of dentin hypersensitivity for patients in their practices.[20-22]

Three topical desensitizers were employed in this study. Gluma (Heraeus Kulzer, Armonk, NY, USA), also a non-fluoride product, is one of the systems marketed solely for the treatment of dentin hypersensitivity.[22-23] Duraphat (Colgate Oral Pharmaceuticals, Inc, New York, NY, USA) is a varnish with high fluoride content and is said to improve the discomfort of dentin hypersensitivity.[22-24] Duraphat was suggested as an effective agent for dentin hypersensitivity.[25-27] UltraEZ (Ultradent Products, Inc, South Jordan, UT, USA) consists of potassium nitrate, which penetrates into dentinal tubules and depolarizes the nerves, decreasing the painful stimulus.[28-29]

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Only a few studies have evaluated the effectiveness of the desensitizing agents *in vivo*.[22,26-27,30-32] Hence, it was considered worthwhile to assess the efficacy of these desensitizing agents in providing short-term relief from dentin hypersensitivity and to help the clinician choose the most effective treatment solution for dentin hypersensitivity.

METHODS AND MATERIALS

Patients who visited the outpatient clinic of Gülhane Military Medical Academy for dental hypersensitivity complaints were assessed for inclusion into the study group. The exclusion criteria for the study were as follows: patients who had dental pathology causing pain similar to cervical dentinal hypersensitivity (such as teeth with caries, the presence of orthodontic appliances and restorations and/or the presence of a history of periodontal surgery in the area of the tooth during the previous three months), patients who had taken any medication, patients who received professional treatment with desensitizing agents in the previous six months, patients who received any treatment in the past 30 days, those patients who were pregnant or lactating and patients who had any systemic diseases and/or the presence of a vital bleaching history. The informed consent was prepared and obtained according to the Helsinki Declaration II. Patients were only included if they had read and signed the informed consent form for the current study.

Two hundred and eight teeth from 52 patients (26 men and 26 women ranging in age from 17 to 51, with a mean age of 33.42 ± 7.663 years) were included in the study. Each patient had four incisors, canines or premolars with exposed cervical dentin on the facial surface that could be affected when air and a cold stimulus (ice chips) was applied. The desensitizing agents used in the current study were Duraphat (Colgate Oral Pharmaceuticals Inc), Gluma (Heraeus Kulzer) and UltraEZ (Ultradent Products, Inc). In addition, the authors of the current study used distilled water as the placebo. Sensitivity was assessed by means of thermal and thermal/evaporative stimuli. A blast of water and a blast of air were applied at a 0.5 cm distance to the tooth surface, respectively, for this purpose. All the stimuli were applied on the cervical region of the experimental teeth and the adjacent teeth were isolated with cotton rolls and a suction device. The authors of the current study did not extend the air stream and ice contact longer than necessary to generate a response. The patients were given a VAS (Visual Analogue Scale) upon which they were asked to place a pencil mark at a point on a linear scale marked from 0 to 100 to describe the pain experienced. After each stimulus to the suspected site, the degree of hypersensitivity was determined from 0 to 100 as the baseline VAS score for each individual painful tooth.

Randomization

After recording the first scores, the subjects were randomly assigned to one of the treatment groups or the placebo. The subjects were blind to the agent being used. The randomization process was conducted before the clinical steps. The randomization procedure was carried out by using sequentially numbered opaque-sealed envelopes (SNOSEs) prepared with unrestricted (simple) randomization.[33-34] Each treatment agent and placebo was written and sealed in envelopes before beginning the study. The dental operator who carried out all the treatments opened an envelope for each case at the beginning of the treatment.

The manufacturers' instructions were followed during the application of the agents. Two coats of Duraphat were applied and repeated after five minutes. This was to ensure adequate desensitization, because of the thin film produced with these materials. Two layers of Gluma and two applications of UltraEZ were also applied to ensure adequate desensitization. For Gluma, the air-inhibited surface was removed by gentle wiping with a damp pellet. All the patients were instructed not to brush or chew food for three hours following treatment. The patients were to maintain the same eating habits and good oral hygiene during the course of the investigation. All the patients were recalled at 24 hours and seven days after completion of the treatment for assessment of their responses to the sensitive teeth.

Statistical Analysis

In the current study, the descriptive statistics were given as mean ± standard deviation, number and percent. For normality testing of variables, the Shapiro-Wilk's test and the homogeneity of the variance Levene test were used. The ANOVA test was used for testing differences between the treatment and age groups, and the student's *t*-test was used for testing differences between the male and female groups. Statistical analyses were performed using the SPSS 11.0 program (SPSS Inc, Chicago, IL, USA) for Windows. The value $p \leq 0.05$ was considered "statistically significant."

RESULTS

The pain scores of the patients were scaled with VAS before application of the desensitizer agent and placebo. Fifty-two patients in the study were distributed into four groups as Gluma, UltraEZ, Duraphat and the placebo group by using the simple random sampling method. Each group comprised 13 subjects, each of which was treated with agents sequentially numbered in opaque-sealed envelopes (SNOSEs). The descriptive statistics of the groups are given in Table 1.

The goodness of fit tests of all variables was tested by using the Shapiro-Wilk test and it was found that all of them distributed normal ($p<0.05$). In a similar manner,

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the homogeneity of the variances was tested by using the Levene test and it was also found that the variances were homogeneous. Due to normal distribution and homogeneity of the variance one-way analysis of variance, ANOVA was used for testing differences between the groups.

It was seen that the minimum pain level was 40, while the maximum pain level was 76, and the mean level of pain was 59.19 (sd 8.9) before treatment. Within 24 hours of treatment, the mean VAS score decreased from 54.38 to 46.15 for Gluma, from 63.46 to 52.69 for UltraEZ and 57.15 to 48.00 for Duraphat. Within 24 hours of treatment, 57.6 % (n=30) of the teeth treated with Gluma became painless (0 VAS score), followed by Duraphat (n=28) and UltraEZ (n=27), 53.8% and 51.9%, respectively. More than 90% of the teeth evaluated after seven days for the Duraphat, Gluma and UltraEZ treatment were painless, while no change was detected in sensitivity for the placebo group (Table 2).

Application of the agents resulted in a significant reduction in dentin hypersensitivity within 24 hours and was sustained throughout the evaluation period ($F=6.670$; $p=0.001$). As a result, there was also a significant decrease between 24 hours and the seven-day evaluation period ($p<0.05$). There was no statistical significance among the agents in terms of the degree of pain reduction both at 24 hours and seven days ($p>0.05$). For clarifying the sources of differences, the Bonferroni post-hoc test was used, and it was found that the placebo group was extremely different from the other groups ($p<0.05$). For the placebo group, the statistical analysis of data revealed no significant difference at three examination periods ($p>0.05$), and there was no decrease in dentin sensitivity for this group (Table 3).

The authors of the current study also investigated the relationship between gender and dentin sensitivity by using the ANOVA test. In female patients, the baseline VAS score average was 60.00 ± 9.156, while in male patients, it was measured as 58.38 ± 8.741. Although male patients were more pain resistant than female patients, a 1.62 units VAS score difference between male and female groups was not statistically significant ($t=0.651$; $p=0.518$).

Age and gender have no significant effect on VAS scores, therefore, age and gender is not used in high level tests.

DISCUSSION

Dentin hypersensitivity is one of the most common and uncomfortable conditions affecting oral comfort and function. Studies regarding the prevalence of cervical dentin hypersensitivity have reported that 4% to 57% of adults experience cervical dentin hypersensitivity in one or more teeth.[35-36] Some epidemiological studies revealed a prevalence of between 15-18%,[37-38] but other studies emphasized a higher prevalence of up to 50%.[39-40]

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Table 1: *The distribution of age, gender and baseline VAS scores according to treatment groups.*

	Gender (n)			Age (years)			Baseline VAS Scores		
Groups	**Male**	**Female**	**Total**	**Range**	**Mean**	**sd**	**Min-max**	**Mean**	**sd**
Gluma	7	6	13	23-45	32.77	6.327	41-65	54.38	7.018
UltraEZ	6	7	13	23-44	33.08	7.308	51-74	63.46	6.960
Duraphat	7	6	13	17-43	33.77	8.438	40-76	57.15	10.032
Placebo	6	7	13	23-51	34.08	9.151	46-75	61.77	9.048

Table 2: *The presence of painful teeth (hypersensitivity) at 24 hours and seven days post-treatment.*

		Gluma	UltraEZ	Duraphat	Placebo
Number of teeth with sensitivity at baseline		52	52	52	52
24 hours	Painless (0 VAS score)	30	27	28	0
7 days	Teeth with sensitivity	22	25	24	52
	Painless (0 VAS score)	50	48	48	0
	Teeth with sensitivity	2	4	4	52

Table 3: *Mean pain (VAS) scores and standard deviations at baseline, 24 hours and seven days for the desensitizing agents and placebo group.*

	Gluma (VAS Scores)			UltraEZ (VAS Scores)			Duraphat (VAS Scores)			Placebo (VAS Scores)		
	Range	**Mean**	**sd**	**Range**	**Mean**	**sd**	**Range**	**Mean**	**sd**	**Range**	**Mean**	**sd**
Baseline	41-65	54.38	7.018	51-74	63.46	6.960	40-76	57.15	10.032	46-75	61.77	9.048
24 hours	36-56	46.15	6.296	44-59	52.69	5.040	39-67	48.00	8.327	45-72	59.54	8.432
7 days	1-17	6.31	4.385	1-13	6.08	4.232	1-11	5.62	3.324	43-70	60.15	7.537

Dentin hypersensitivity is reported more frequently in women,[2] which is consistent with the present day study.

In the current study, the effectiveness of the agents was evaluated with VAS, which is widely used in human clinical and psychological research to assess subjective states. It is based on a 100 mm scale; the extreme left side indicated zero pain and the extreme right, maximal pain. Research subjects are asked to indicate their response by marking a position on the line between the two extremes.[41-42]

The results of the prevailing study indicated that all experimental agents caused a significant reduction in dentin hypersensitivity for at least one week. This finding was supported by the results of previous studies[22,26,29,31-32,43-44] that reported the effectiveness of copal varnish, Duraphat, Gluma, Seal&Protect, Vivasens, BisBlock and iontophoresis in reducing dentin hypersensitivity. The results of the current study indicate that a single application of three different kinds of desensitizing agents reduce dentin hypersensitivity in a short-term treatment period. Ritter and others[18] reported similar results in their study with two fluoride varnishes, but in a long-term evaluation (24 weeks). They also reported that the majority of subjects experienced only minor improvement after treatment and only a few indicated major improvements. Meanwhile, Corona and others[27] compared the efficacy of a 5% NaF varnish and low-level laser therapy in the reduction of cervical dentin hypersensitivity. They followed-up with subjects for only 30 days after treatment, and they found that both treatments were effective. In addition to their desensitizing effect, topical fluoride varnishes help to prevent caries,[45-48] but their potential to stain esthetic restorations when used as desensitizing agents should be kept in mind.[49-50]

It has been indicated that some desensitizing agents containing glutaraldehyde and HEMA, such as Gluma, kill bacteria and coagulate plasma proteins within the dentinal fluids, forming a coagulation plug.[4,22,29] In a very recent study, Olusile and others[22] evaluated the effectiveness of four topical desensitizing agents (Gluma, Duraphat, 2% fluoride iontophoresis, copal varnish) in providing short-term relief of dentin hypersensitivity. They found that the agents caused a statistically significant reduction in dentin hypersensitivity within 24 hours of treatment. Gluma performed best at 24 hours, while iontophoresis appeared to have an edge at seven days. These findings are consistent with the results of the prevailing study. The authors of the current study also found Gluma to be the most effective agent, but without a significant difference with others. However, in the opinion of the authors of the current study, the evaluation period should be extended to evaluate the long-term effectiveness of these agents.

In a recent study, Pamir and others[30] compared the efficacy of three different desensitizers (resin-based desensitivity agent, potassium fluoride and oxalic acid) and distilled water for the placebo group, similar to the current study. Pamir and others reported that these three agents, which act by blocking the dentin tubules, were effective in relieving dentinal hypersensitivity. They also reported that their effectiveness was similar to each other but different from the placebo. The authors of the current study found similar results regarding the products they compared. Additional studies should be conducted to investigate the real benefits of these materials in terms of cost, ease of manipulation and patient satisfaction before recommending their routine application in dentistry.

CONCLUSIONS

It can be concluded that the desensitizing agents used in the current clinical study were effective in relieving dentin hypersensitivity. The short-term treatment of dentin hypersensitivity with Gluma, Duraphat and UltraEZ showed a statistically significant reduction in the sensation of pain when compared with the placebo.

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