Clinical Assessment of Bond and Fluoride in Dentin Hypersensitivity

Bond ve Florun Dentin Hassasiyetinde Klinik Olarak Değerlendirilmesi

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ABSTRACT

Objective: The study was conducted to evaluate the efficacy of two widely used desensitizing agents for the treatment of dentin hypersensitivity.

Materials and Methods: Thirty-six exposed sensitive teeth were divided into three groups. In group 1, a single bond was applied, while in group 2, sodium fluoride (NaF) varnish was utilized to treat hypersensitivity. Sensitivity records were measured with VAS (Visual analogue scale). Moreover, twelve extracted human teeth were used in order to demonstrate ultrastructural differences between the replica and direct SEM techniques.

Results: After both desensitizing procedures, most of the patients reported distinct reductions in dentin sensitivity at the baseline, but a statistically significant difference was not observed between the two agents. However, the SEM analysis revealed that bondina sealed more dentin tubules than the fluoride varnish.

Conclusion: The results of the present study demonstrated that both agents are efficient in the treatment of hypersensitivity.

KEYWORDS
Dentin hypersensitivity, Bond, Sodium flouride

ÖZET

Amaç: Bu çalışma dentin hassasiyeti tedavisinde sıklıkla kullanılan iki hassasiyet giderici maddenin etkinliğini değerlendirirmek için gerçekleştirilmiştir.

Gereç ve Yöntem: Dentin hassasiyeti bulunan 36 dış üç gruba ayrılmıştır. Dentin hassasiyetinin tedavisinde birinci gruptaki örneklerde bond uygulanırken ikinci gruptakilere sodum florid uygulanmıştır. Sensitivite kayıtları VAS (visual analogue scale) ile ölçülmüştür. Bunun dışında, çekilmiş 12 adet diş replica ve direk SEM tekniği arasındaki mikroskopik farklarını göstermek için kullanılmıştır.

Bulgular: Her iki haxasitet metodunun uygulanmasından sonra, hastaların çoğu dentin hassasiyetleri başlangıça göre belirgin bir azalmayı bildirmişlerdir, fakat iki madde arasında istatistiksel olarak anlamlı bir fark görülmemiştir. Bununla beraber SEM incelemesi bondon flor jellinden daha fazla tabi tuttuğu göstermiştir.

Sonuç: Bu çalışmanın bulguları her iki maddenin de hassasiyet tedavisinde etkili olduğunu göstermiştir.
INTRODUCTION

Dentin sensitivity is characterized by a short, sharp pain arising from exposed dentin, typically in response to thermal, chemical, tactile or osmotic stimuli. A review of the literature indicates that cervical dentin sensitivity is experienced by about 15% of the population. Although, hypersensitivity is dependent on exposed dentin surface texture and the dentin tubules, all exposed dentin surfaces are not sensitive. Exposure of root dentin can occur due to abrasion, attrition, erosion of enamel and cementum. Tubule patency may depend on the presence or absence of a smear layer, the number of exposed tubules, the size and the status of the pulp chamber, and the presence of sclerotic dentin. The hydrodynamic theory is generally accepted as regards dentin hypersensitivity. It is explained by a stimulus transmission mechanism by dentin fluid movement. The theory is later confirmed with a neurophysiological test. Several desensitizing agents have been used to prevent hypersensitivity. Considering the mechanism of action and the treatment modalities, the agents can be assigned to three main groups: anti-inflammatory agents, therapeutic tubule occlusive agents, and those with an effect on the depolarization of nerve endings. The most commonly used products are those which promote partial or total closure of dentinal tubules, such as oxalates, resin bonding agents, and formulations containing potassium ions. These agents interfere with the hydrodynamic mechanism, as they act on the exposed sensitive area, reducing the number of open dentinal tubules or decreasing their diameter; thereby minimizing the movement of dentinal fluid.

Sodium fluoride has also been indicated as a way of treating dentine hypersensitivity and is available in a variety of forms. The use of fluoridating varnishes with sodium fluoride as the active ingredient (in high concentrations) has been advocated to increase the duration of action of sodium fluoride in contact with exposed dentin, thus aiming to enhance its effectiveness in decreasing dentine sensitivity. However, the attempt to provide tubule closure is relatively short lived because the therapeutic quality of the varnish comes out gradually; and the varnish can be removed before its desensitizing effect has been achieved with simply by brushing teeth.

Therefore, the aim of the present study was to compare the effectiveness of the bonding agent and fluoride varnish to reduce dentine hypersensitivity.

MATERIAL AND METHOD

The research protocol was approved by the research committee at the Gulhane Military Medical Academy. The subjects were selected out of the patients referred to the Dental Sciences Center at the Department of Periodontology. To participate in the study, the subjects had to have three teeth with cervical abrasion or gingival recession that were hypersensitive to tactile and evaporative stimulation. All patients were asked to sign the informed consent form.

The patients were excluded from the study if they;

- Were under analgesic, anti-inflammatory or anti-depressive treatment regimens,
- Had eating disorders,
- Were pregnant,
- Were undergoing orthodontic therapy, or
- Had cognitive disfunctions or general communication difficulties.

The patients’ teeth were excluded if they;

- Had been subjected to periodontal surgery within the past three months,
- Had congenital tooth crown defects,
- Had carious lesions
- Had restored or fractured teeth,
- Had non-vital or had symptoms of pulp damage, or
Had undergone anti-hypersensitive therapy within the last 30 days.

Twelve male and female patients between 25-45 years of age were selected for the study. The patients were instructed to brush their teeth three times a day and monitored for two weeks prior to the study. Thirty six teeth were selected from the patients who fulfilled all criteria. Then, the teeth randomly divided into three groups: two test groups and one control group.

**Pain Assessment**

Two methods were applied on the subjected teeth to provoke a hypersensitivity reaction:

**Tactile Stimulation**

The stimulation was provoked by a Williams Periodontal probe. The probe was dragged laterally and vertically on the exposed root surface.

**Air blast Stimulation**

This method was performed two minutes after the tactile scoring procedure by means of a standard air syringe from the dental unit.

All stimuli were performed after all subjected teeth had been cleaned with a cotton pellet soaked in warm distilled water, and dried. The stimulus was delivered until a reaction was observed, or up to a maximum duration of 5 seconds. All stimuli were given by one operator, in the same dental chair with the same equipment and the pain was assessed with the VAS (Visual Analogue Scale) by another clinician.

The patients’ reactions to the stimuli were recorded before and after the treatment, and then at one-week intervals for four weeks.

**Treatment Procedure**

After the baseline pain assessment, test group teeth were split into two groups. The test materials were applied as follows:

**Group 1:** After cleaning the tooth surface with a cotton pellet soaked in distilled water, the bonding agent (Adper™ single bond containing 2-hydroxyethylmethacrylate 3M ESPE USA) was applied onto the exposed tooth surface as per the manufacturer’s recommendations. Group 2: The fluoride varnish (Nupro® containing 2.59% sodium fluoride DENTSPLY USA) was applied onto the exposed tooth surface and after 2 minutes, the hypersensitivity reaction was assessed.

In the control group teeth, a placebo (cotton pellet soaked in warm distilled water) was applied onto the teeth and after 2 minutes VAS scores were measured.

**SEM (Scanning electron microscopy) Analysis**

Twelve extracted caries-free human third molars were included in the study. Specimens were fixed in 2% neutral buffered glutaraldehyde and dehydrated in ascending concentration of ethanol 70% to 99.9% under vacuum. The dehydrated specimens penetrated and set in methacrylate (Technovit® 7200 VLC., Heraeus Kulzer GmbH & Co. KG, Wehrheim, Germany) without decalcification. The resulting blocks were sectioned sagittally (Exakt 300 CL, Exakt Apparatbau, Norderstad, Germany). Only one dentin disc, which was 1mm thick, was obtained from each tooth. The dentin surface of each disc was divided into 2 areas by a longitudinal scratch. The dentin discs were etched with 6% citric acid for 2 min and rinsed in distilled water. Wet silicon carbide sandpaper was used for 5 seconds on the both side of each disc to create a standard smear layer. Each disc was then conditioned with 6% citric acid for 2 min on both sides and rinsed in distilled water in order to expose the dentinal tubules and simulate hypersensitive dentin. The smear layers on the other part of discs served as control for the exposed dentin. Desensitizing agents were then applied onto the exposed tubules. The specimens were randomly divided into two groups. In the first group, the six dentin discs were analyzed in SEM. The other six specimens were embedded in Permadyne impression material to investigate dentin surfaces with indirect SEM method. The epoxy-resin material (Araldite resin CY212 + Dodoceny
Succinic Anhydride (DDSA) + Benzyl Dimethylamine (BDMA) TAAB® UK) mixed according to the manufacturer’s recommendations then was placed under pressure in a vacuum chamber for 3 minutes to remove air bubbles. The resin was carefully poured into the impression to avoid any bubbles. The replicas were allowed to bench set for 24 hours and then processed for the SEM observation.

Statistical Methods
The scores of VAS of each group were analyzed with the Friedman test for tactile and air blast stimulation methods. If a statistical significance was found, the Wilcoxon signed rank test was used to determine the statistically significant period of examination. In the control group, there was no significant difference between the periods, although there was in bond and sodium fluoride group. Therefore, it was decided that the differences in the VAS scores between the baseline measurement and each recall of the test groups would be analyzed and the Mann-Whitney U test would be used.

RESULTS

Clinical Results
In the comparison made between the desensitizing treatments, the statistical analysis of data revealed no significant difference between bond and fluoride varnish (Table II, IV). In addition, the differences between examination periods of the control were not significant (Table I, III). When the therapies were considered separately, significant differences were observed between the initial measurements and five examination periods of both agents using air-blast and tactile stimulation. However, the hypersensitivity analysis of the bond group using tactile stimulation indicated a marked difference only between baseline measurement and after the application of the material; other examination periods showed no difference following tactile stimulation (Table I, II).

The analysis between air blast stimulation and tactile stimulation in the bond group presented a statistical difference only between baseline measurement and after the application of bond (Table V). In contrast, the results of fluoride varnish group indicated statistically significant differences between baseline measurement and all examination periods (Table VI).

SEM Investigation
Both desensitizing agents revealed that dentin tubules were sealed. However, partial closure of dentin tubules in fluoride varnish group indicated that the bond could be more efficient for treating sensitive teeth (Fig 1, 2).

<table>
<thead>
<tr>
<th>Measurements Groups</th>
<th>Group 1 (Bond)</th>
<th>Group 2 (Fluoride)</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline pain score</td>
<td>70 (10-100)</td>
<td>55 (20-100)</td>
<td>50 (30-90)</td>
</tr>
<tr>
<td>2 minutes</td>
<td>30 (0-80)*</td>
<td>20 (0-90)*</td>
<td>55 (30-80)</td>
</tr>
<tr>
<td>1st week</td>
<td>40 (0-80)*</td>
<td>20 (0-80)*</td>
<td>50 (20-90)</td>
</tr>
<tr>
<td>2nd week</td>
<td>45 (0-80)*</td>
<td>15 (0-60)*</td>
<td>50 (30-90)</td>
</tr>
<tr>
<td>3rd week</td>
<td>40 (0-80)*</td>
<td>20 (0-60)*</td>
<td>55 (20-90)</td>
</tr>
<tr>
<td>4th week</td>
<td>45 (0-80)*</td>
<td>20 (0-70)*</td>
<td>55 (20-90)</td>
</tr>
</tbody>
</table>

* Indicates statistically significant differences between the baseline pain score and the related examination period.
### TABLE II

**Statistical differences between bond and fluoride groups using air-blast stimulation**

<table>
<thead>
<tr>
<th>Measurements</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline-2minutes</td>
<td>0.671</td>
</tr>
<tr>
<td>Baseline-1st week</td>
<td>0.443</td>
</tr>
<tr>
<td>Baseline-2nd week</td>
<td>0.114</td>
</tr>
<tr>
<td>Baseline-3rd week</td>
<td>0.085</td>
</tr>
<tr>
<td>Baseline-4th week</td>
<td>0.09</td>
</tr>
</tbody>
</table>

### TABLE III

**Dentin sensitivity scores using tactile stimulation. Median (Min-Max values)**

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group 1 (Bond)</td>
</tr>
<tr>
<td>Baseline pain score</td>
<td>45 (0-90)</td>
</tr>
<tr>
<td>2 minutes</td>
<td>0 (0-60) *</td>
</tr>
<tr>
<td>1st week</td>
<td>0 (0-80)</td>
</tr>
<tr>
<td>2nd week</td>
<td>20 (0-90)</td>
</tr>
<tr>
<td>3rd week</td>
<td>20 (0-80)</td>
</tr>
<tr>
<td>4th week</td>
<td>20 (0-90)</td>
</tr>
</tbody>
</table>

*Indicates statistically significant differences between the baseline pain score and the related examination period.

### TABLE IV

**Statistical differences between bond and fluoride groups using tactile stimulation**

<table>
<thead>
<tr>
<th>Measurements</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline-2minutes</td>
<td>0.743</td>
</tr>
<tr>
<td>Baseline-1st week</td>
<td>0.904</td>
</tr>
<tr>
<td>Baseline-2nd week</td>
<td>0.434</td>
</tr>
<tr>
<td>Baseline-3rd week</td>
<td>0.603</td>
</tr>
<tr>
<td>Baseline-4th week</td>
<td>0.750</td>
</tr>
</tbody>
</table>
### TABLE V

Statistical analysis results of the comparison of airblast and tactile stimulation of bond group.

<table>
<thead>
<tr>
<th>Measurements</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline pain score- Baseline treatment</td>
<td>0.0005*</td>
</tr>
<tr>
<td>Baseline pain score-1st week pain score</td>
<td>0.160 N.S</td>
</tr>
<tr>
<td>Baseline pain score-2nd week pain score</td>
<td>0.219 N.S</td>
</tr>
<tr>
<td>Baseline pain score-3rd week pain score</td>
<td>0.206 N.S</td>
</tr>
<tr>
<td>Baseline pain score-4th week pain score</td>
<td>0.219 N.S</td>
</tr>
</tbody>
</table>

*indicates statistically significant differences. N.S: non significant

### TABLE VI

Statistical analysis results of the comparison of airblast and tactile stimulation of fluoride group.

<table>
<thead>
<tr>
<th>Measurements</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline pain score- Baseline treatment</td>
<td>0.0005*</td>
</tr>
<tr>
<td>Baseline pain score-1st week pain score</td>
<td>0.02*</td>
</tr>
<tr>
<td>Baseline pain score-2nd week pain score</td>
<td>0.017*</td>
</tr>
<tr>
<td>Baseline pain score-3rd week pain score</td>
<td>0.006*</td>
</tr>
<tr>
<td>Baseline pain score-4th week pain score</td>
<td>0.006*</td>
</tr>
</tbody>
</table>

*indicates statistically significant differences. N.S: non significant

### FIGURE 1

SEM investigation of bond applied dentin disc. Bond application sealed all dentin tubules in the test side. A: Control side B: Test side
However, indirect SEM investigation was not able to show the appearance of dentin surface.

DISCUSSION

The etiology of dentin sensitivity is still at hypothetical level. Based on these hypotheses, different desensitizing mechanisms have been proposed: Occluding dentin tubules, coagulating or precipitating tubular fluids, stimulating the formation of secondary dentin and blocking the pulpal neural response. Based on these hypotheses, different desensitizing mechanisms have been proposed: Occluding dentin tubules, coagulating or precipitating tubular fluids, stimulating the formation of secondary dentin and blocking the pulpal neural response. In accordance with these mechanisms, some agents have been used for the treatment of dentin sensitivity, for example potassium nitrate, strontium chloride, potassium citrate, sodium fluoride, sodium monofluorophosphate, stannous fluoride, and several types of treatment such as mouthwash, toothpastes, and gels have been suggested. However, the results of previous studies have indicated that the desensitizing agents could not completely treat sensitive dentin. This result may explain the most acceptable theory (Hydrodynamic theory). It is possible for any of these agents to seal the exposed dentin tubules. Therefore, the liquid in the tubules cause a pressure on nerve fibrils and dentin hypersensitivity occurs. In addition, the failure in long-term results can be attributed to the fact that the agents are not resistant to saliva or attrition.

The present study aims to compare the clinical and histopathological results of fifth generation bonding agent and NaF varnish on dentin hypersensitivity. These materials are widely used to treat hypersensitivity by many clinicians. However, the results of comparative studies are very limited and have contradictory results. The fifth generation bonding agents contain mostly HEMA which is a water miscible adhesive monomer, characterized by a high wettability. Good penetration into tubules may produce resin tags within the tubules, occluding them after light curing. The chemical connection is created for collagen fibers demineralized dentine and micromechanical permeation of the same collagen fibers with molecules of hydrophilic monomers. Therefore, they have been accepted to be successful in dentin hypersensitivity.

On the other hand, the action of NaF varnish may be attributed to the reaction that occurs between NaF and Calcium ions of dentinal fluid, and that leads to the formation of calcium fluoride crystals, which are deposited onto the openings of the dentinal tubules. Authors have indicated that the crystal size of calcium fluoride (CaF₂) was small, and therefore, a single application of NaF would not be effective in narrowing down the diameter of dentinal tubules and multi-

FIGURE 2

SEM investigation of fluoride varnish applied dentin disc. Fluoride application partially sealed dentin tubules. A: Control side B: Test side
ple applications should be necessary\textsuperscript{18}. However, the statistical results of our study have not indicated a difference between bond and fluoride applications. Ultrastructural investigation of dentin discs showed that the bondina agent was more effective in sealing the dentine tubules than the fluoride varnish. Nevertheless, the microscopic investigation was carried out on extracted tooth surfaces. Hence, samples for the microscopic evaluation were not exposed to oral environment for very long. Based on these results, it would not be correct to report which material is more effective in dentin hypersensitivity.

It was assumed that widely used stimulation methods have some deficiencies that affect their reproducibility and complicate longitudinal monitoring of hypersensitivity\textsuperscript{22}. The VAS method is widely used in clinical research to assess the intensity of acute pain. However, it is very difficult to translate subjective feedback into objective data for research purposes. Therefore, the results from the VAS are questionable. We believe that it is very important to form a well-designed control group to prevent the indefiniteness of the scores. The control group may help to compare the subjective data of patients and to interpret them in an objective manner. Statistical insignificance in our control group was evaluated as we had obtained objective results in the test groups.

The most common stimuli used in clinical studies are thermal and tactile stimuli. An air blast from water syringe has been used in the majority of studies as means of combining thermal and evaporative stimulation of sensitive dentine. The stimulus is operator controlled for duration and is poorly reproducible. It is generally accepted that a thermal stimulus should be supplemented by the use of a tactile stimulus\textsuperscript{23}. This is frequently a hand held probe, which is dragged over the dentine surface. However, tactile tests involving lateral movements with hand held instruments are known to cause problems in terms of reproducibility. In particular, misalignment of the probe tip may alter the load applied to the tooth surface\textsuperscript{24}. Furthermore, the area of hypersensitivity may not involve all of an exposed dentine surface on a single tooth and may even change location between assessments\textsuperscript{25}. In our study, the results of NaF group revealed that air blast stimulation is more effective than tactile stimulus in the assessment of pain measurement. However, the same result was not observed in the bond group. The difference between two groups can be due to the chemical properties of these materials since the SEM analysis revealed that the fluoride varnish did not completely seal the dentin tubules. Therefore, air-blast stimulation could be more efficient in measuring pain. Furthermore, the tactile stimulus was not assumed to be very reproducible. Hence, the scores obtained in the NaF group were not able reflect the real pain scores of the patients. Although, a previous study\textsuperscript{17} indicated good validity for the tactile stimulus; our data implied that the tactile stimulus was not a valid method of assessing pain measurement.

Another problem in dentin hypersensitivity studies is to evaluate the histopathological changes following the application of the desensitizing agents. The present study assessed two methods. In the indirect SEM study, we did not observe histopathological differences in the impressions of the extracted third molars. Nevertheless, some authors have ended up with contradictory results\textsuperscript{16}. It would be correct to suggest that the quality of the impression material and epoxy resin is very important in obtaining definite results. Therefore, a polyvinyl silicone material (Permadyne) and a widely used epoxy resin material were used.

In conclusion, dentin hypersensitivity studies are subject based. Therefore, several factors can influence the measurement of pain. To date, none of the methods used to assess the measurements have been seen to be completely successful. However, it may be suggested that the aim in dentin hypersensitivity studies is to relieve patients’ discomfort. Hence, long-term studies and repeated applications of desensitizing agents are necessary. In addition, well-designed control groups and working with more subjects may be of great help in obtaining more reliable results.
REFERENCES

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