Effect of Fluoride Varnish on Demineralization Adjacent to Orthodontic Brackets

SUMMARY

Application of fluoride varnish is a preventive protocol that does not require patient compliance and permits the orthodontist to benefit from the bond strength of composite resins. The aim of this study was to compare, in vitro, the effect of a fluoride varnish on inhibition of enamel demineralization adjacent to orthodontic brackets bonded with a resin-modified glass ionomer cement (RMGIC) and a composite resin. A total of 60 extracted human lower and upper premolars with no restorations, caries, and hypoplastic areas or pliers impressions were collected for this study. All teeth were cleaned and cut in half bucco-lingually with a diamond disc. The following adhesives for bonding brackets were used in this study: Con Tec LC (Dentaurum, Germany) and resin-modified glass ionomer cement Fuji Ortho LC (GC Corporation, Japan). Brackets in each group were bonded with a type of adhesive according to manufacturers’ bonding instructions. After brackets bonding, the premolars (test specimens) were kept dried carefully and the enamel received a single topical application of a fluoride varnish (Duraphat®; Germany) with the aid of a brush applicator. 3 minutes later, the teeth were wet with mild air/water spray and stored in artificial saliva until analysis, after 14 days and 1 month. Fluoride concentrations were measured by spectrophotometer.

The results obtained indicated a significant increase in the levels of fluoride uptake in enamel after the use of resin-modified glass ionomer cement for bonding brackets and topical application of a fluoride varnish. Use of a fluoride varnish, when bonding brackets with GICs, is more effective in preventing enamel demineralization than the conventional composite resin. Based on these findings, it may be concluded that the examined fluoride varnishes had impact on the inhibition of enamel demineralization adjacent to orthodontic brackets.

Keywords: Enamel; Brackets; Decalcification; Fluoride Varnish

Introduction

It is well known that orthodontic treatment with fixed appliances predisposes patients to a larger accumulation of bacterial plaque and, hence, to enamel demineralization. This is due to the mechanical interference imposed by the orthodontic appliances, maintaining adequate oral hygiene more difficult. Consequently, enamel demineralization lesions, resulting from dissolution of the enamel, can appear within only a few weeks after appliance placement1,2. These enamel scars can vary from microscopic alterations to visible “white spot lesions” that may reach cavitations3. The presence of these lesions is not usually observed until the removal of orthodontic appliances and has been reported to be a frequent event4,5. Although previously published reports have indicated that molars are more susceptible to white-spot formation because of difficulties in maintaining plaque control, the 6 maxillary anterior teeth are considered separately6.
Fluoride is important in the prevention of enamel demineralization. There are several methods of delivering fluoride to teeth in patients during orthodontic treatment (in addition to fluoridated toothpaste). These include:
- topical fluorides (e.g. mouthrinse, gel, varnish, toothpaste);
- fluoride-releasing materials (e.g. bonding materials, elastics).

Application of fluoride varnish is a preventive protocol that does not require patient compliance and permits the orthodontist to benefit from the bond strength of composite resins. Prolonged contact time with fluoride varnish permits significantly more incorporation of fluoride than with other fluoride applications, e.g. acid phosphate fluoride gel, monofluor phosphate dentifrices, home fluoride rinses7,8. For instance, Petersson et al9 observed that a 3-monthly application of fluoride varnish resulted in a dramatic reduction in caries incidence and the application of a fluoride varnish can be easily adapted to current orthodontic bonding techniques.

Fluoride varnishes have benefit of adhering to the enamel surface longer than other topical fluoride products. Thus, fluoride varnishes have been reported to be superior to sodium fluoride and monofluorophosphate dentifrices in their ability to increase fluoride uptake in enamel10. An increase was also found after 3 weeks when comparing fluoride varnish with 2% sodium fluoride gel applied weekly, 2% acidulated phosphate fluoride gel applied weekly, or 0.25% sodium fluoride rinse used daily. Teeth with fluoride varnish applied around composite resin-bonded brackets showed a 35% reduction in demineralised lesion depth11. Teeth with RMGIC (resin-modified glass-ionomer cement)-bonded brackets demonstrated a 50% reduction in lesion depth with or without fluoride varnish application. The RMGI adhesives have been demonstrated to sustain fluoride release long after initial application, but they only protect a limited area immediately adjacent to the orthodontic bracket. In addition, bond failures with RMGIC have been found to be similar or worse than composite resins12-14.

The aim of this study was to compare, in vitro, the effect of a fluoride varnish on inhibition of enamel demineralization adjacent to orthodontic brackets bonded with a RMGIC and a composite resin.

## Material and Methods

A total of 60 extracted human lower and upper premolars with no restorations, caries, and hypoplastic areas or pliers impressions were collected for this study. All extractions were indicated for orthodontic purposes in patients of 11-18 years of age. After being extracted, teeth were stored in artificial saliva and were divided in 4 groups of 30 teeth (Tab. 1). All teeth were cleaned and cut in half bucco-lingually with a diamond disc. Thus, the control and test specimens were obtained from the same teeth.

### Table 1. Sample preparation

<table>
<thead>
<tr>
<th>Group number</th>
<th>Bonding agent</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dentaurum</td>
<td>no Duraphat</td>
</tr>
<tr>
<td>2</td>
<td>Dentaurum</td>
<td>with Duraphat</td>
</tr>
<tr>
<td>3</td>
<td>Fuji Ortho LC</td>
<td>no Duraphat</td>
</tr>
<tr>
<td>4</td>
<td>Fuji Ortho LC</td>
<td>with Duraphat</td>
</tr>
</tbody>
</table>

After etching the enamel surface with a 37% phosphoric acid solution for 15 seconds and rinsing for 10 seconds, teeth were dried. Each bracket was positioned over the mid point of the clinical crown on buccal and lingual surfaces of the prepared premolar and pressed firmly onto the surface. Any excess adhesive was removed. The following adhesives for bonding brackets were used: Con Tec LC (Dentaurum, Germany) and RGIC Fuji Ortho LC (GC Corporation, Japan). Brackets in each group were bonded with the same adhesive according to manufacturers’ bonding instructions. After brackets bonding, the premolars (test specimens) were kept dried carefully and the enamel received a single topical application of a fluoride varnish (Duraphat®; Germany) with the aid of a brush applicator. 3 minutes later, the teeth were wet with mild air/water spray and stored in artificial saliva (20 mmol/l NaHCO₃, 3 mmol/l NaH₂PO₄ and 1 mmol/l CaCl₂, neutral pH) until analysis, which is done 14 days and 1 month thereafter. Fluoride concentrations were measured by spectrophotometer.

For statistical evaluation, a 1-way analysis of variance (ANOVA) followed by Tukey’s test was initially used to see if there was a significant difference between groups.

### Results

#### Table 2. The mean concentrations of total fluoride (ppm) in enamel in the group of teeth brackets bonded with composite resin 14 days after topical application of a fluoride varnish

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t - value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>test</td>
<td>15</td>
<td>1660.608</td>
<td>156.296</td>
<td>3.074</td>
<td>0.01326*</td>
</tr>
<tr>
<td>control</td>
<td>15</td>
<td>150.800</td>
<td>47.726</td>
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<td></td>
</tr>
</tbody>
</table>

Table 2 shows the mean concentrations of total fluoride in enamel in the first group of tooth brackets bonded with Con Tec Duo 14 days after topical
application of a fluoride varnish. The mean value of fluoride in the examined group of teeth was 1660,608 ppm, and in the control group of teeth the value of F was 150,800 ppm. There was a statistically significant difference between values of fluoride in the enamel in both examined groups of teeth.

Table 3 shows the mean concentrations of total fluoride in enamel in the group of teeth brackets bonded with RMGIC Fuji Ortho LC 14 days after topical application of a fluoride varnish. The mean value of fluoride in the examined group of teeth was 924,240 ppm, and in the control group of teeth the mean value of fluoride was 664,052 ppm. There was a statistically significant difference between values of fluoride in the enamel in both examined groups of teeth.

Table 5. The mean concentrations of total fluoride (ppm) in enamel in the group of teeth brackets bonded with Fuji Ortho LC 1 month after topical application of a fluoride varnish

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t - value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>test</td>
<td>15</td>
<td>924.240</td>
<td>428.865</td>
<td>2.152</td>
<td>0.01862*</td>
</tr>
<tr>
<td>control</td>
<td>15</td>
<td>664.052</td>
<td>350.612</td>
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</table>

Table 4 shows the mean concentrations of total fluoride in enamel in the group of examined teeth compared to the control group of teeth 1 month after brackets bonded with Con Tec Duo and topical application of a fluoride varnish. There was a statistically significant difference of the values (389,300 ppm against 143,200 ppm).

Table 4. The mean concentrations of total fluoride (ppm) in enamel in the group of teeth brackets bonded with composite resin 1 month after topical application of a fluoride varnish

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t - value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>test</td>
<td>15</td>
<td>389.300</td>
<td>326.209</td>
<td>2.321</td>
<td>0.04539*</td>
</tr>
<tr>
<td>control</td>
<td>15</td>
<td>143.200</td>
<td>48.928</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. The mean concentrations of total fluoride (ppm) in enamel in the group of teeth brackets bonded with Fuji Ortho LC 1 month after topical application of a fluoride varnish

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t - value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>test</td>
<td>15</td>
<td>534.788</td>
<td>178.327</td>
<td>2.076</td>
<td>0.04238*</td>
</tr>
<tr>
<td>control</td>
<td>15</td>
<td>425.529</td>
<td>183.247</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The mean concentrations of total fluoride in enamel of the examined and control group of teeth 1 month after the bracket bonded with resin-modified glass ionomer cement Fuji Ortho LC and topical application of a fluoride varnish is shown in table 5. After 1 month, a statistically significant difference occurred in the values of fluoride in enamel between the experimental and control groups.

Discussion

During orthodontic treatment, bonded brackets promote more retention of dental plaque and make oral hygiene difficult. A preventive method could be the use of fluoride varnishes. Fluoride varnish applied around orthodontic appliances has been proven to diminish the incidence of white spot lesions. For instance, fluoride varnish, composed of a 5% sodium fluoride in a resin base, has shown a reduction in white spot incidence of about 50%18,19. Therefore, periodic fluoride application may provide a clinically effective solution, although it was observed that such material cannot completely prevent white spots20. Moreover, application of fluoride varnish on existing lesions does prevent their progression and may help remineralisation.

The aim of this study was to evaluate, in vitro, the effect of a fluoride varnish on the inhibition of enamel demineralisation adjacent to orthodontic brackets bonded with a RMGIC and a composite resin. Our investigation was done on 2 different bonding materials most commonly used in orthodontic practice. The results obtained have indicated a significant increase in the levels of fluoride uptake in enamel after the use of RMGIC Fuji Ortho LC for bonding brackets and topical application of a fluoride varnish. The analysis of the value of fluoride in enamel before and after bonding the brackets with Fuji Ortho LC as well as the application of a fluoride varnish clearly showed that after its application the fluoride level in enamel was significantly increased. Thus, the value of fluoride in enamel before bonding the brackets was 664,052 ppm. 14 days after bonding, the amount of fluoride in enamel was 924,240 ppm, which was significantly higher than the initially. After 1 month, the value of the quantity of fluoride in enamel in the examined (first) group was still high (534,788 ppm). The finding from this in vitro study indicates that application of fluoride varnish may inhibit enamel decalcification adjacent to orthodontic brackets.

In our study enamel demineralization in vitro was inhibited to a certain degree. Similar decalcification prevention has been reported by many authors for other fluoride-releasing materials21-23. Besides the positive impact on local fluoride-release, cement used for bonding the brackets provides continuous presence of low concentrations of fluoride in the oral medium, which also influences on inhibition of demineralised enamel around orthodontic brackets and bands.
The positive effects of fluoride varnish presented in this study are in agreement with findings of other reports. 2 of these investigations used Duraflo varnish, which contains the same 5% concentration of sodium fluoride as Duraphat. Daily rinsing with a solution of 0.05% sodium fluoride also reduces the severity of white-spot lesions, although it cannot prevent them completely. The efficacy of this method depends on patient compliance, which has generally been found to be lacking (13%). Patients who do not practice proper oral hygiene are particularly unlikely to cooperate in using mouthrinses.

Conclusions

Use of a fluoride varnish, when bonding brackets with GICs, is more effective in preventing enamel demineralization than the conventional composite resin. Fluoride varnishes examined in this study had impact on the inhibition of enamel demineralisation adjacent to orthodontic brackets. Orthodontists should consider its routine use in clinical practice, especially in patients exhibiting poor oral hygiene.

References


Correspondence and requests for offprint to:
Dr Efka Zabokova-Bilibiova, PhD
Department of Pediatric and Preventive Dentistry
School of Dentistry
Vodnianska 17
1000 Skopje, FYR Macedonia
E-mail: efka_zabokova@hotmail.com