EFFICACY OF FLUORIDE VARNISHES IN THE PROPHYLAXIS OF DENTAL EROSION

Danuta Waszkiel, a Grażyna Marczuk-Kolada, a Małgorzata Grądka-Dahlke

Białystok, Poland

SUMMARY: To evaluate the prophylactic effect of fluoride varnishes on acid erosion of dental enamel, 40 teeth with paracervical erosion lesions located on labial and buccal surfaces were studied in five male and five female patients aged 18–30 years. Teeth on opposite sides of the mouth were coated three or six times at two-week intervals with either Duraphat® or Fluoride-Protector® varnishes. After a year, enamel loss from acid corrosion was measured in the varnished teeth and found to be less with six than with three applications and only slightly different for the two varnishes.

Keywords: Acid erosion; Dental enamel; Duraphat®; Enamel erosion; Fluoride-Protector®; Fluoride varnishes.

INTRODUCTION

Dental erosion is caused by the action of acids on enamel hard tissue. Depending on the extent of acid present in the oral cavity, the causes can be intrinsic or extrinsic. Intrinsic factors are involved when enamel damage occurs by contact of teeth with gastric acid due to chronic vomiting or gastric reflux. Extrinsic causes arise from the environment, diet, medications, and lifestyle, with dietary factors being the most significant.

Because an increased incidence of enamel erosion has been noted in a number of scientific studies, prophylactic management schemes have been proposed to determine and eliminate risk factors as well as to improve resistance of dental hard tissues to the action of demineralizing agents.

The topical protective effect of fluoride against dental caries is widely accepted and promoted for the prevention of tooth decay. Many authors associate the reduced incidence of caries observed in the European countries with topical application of fluoride preparations. However, the efficacy of fluorides for protection against dental erosion is presumptive and equivocal. Experiments carried out on animal models have demonstrated a protective effect of topical fluoride compounds on dental hard tissues against acid-induced demineralization, which, however, has not been confirmed in humans.

The aim of this study was to evaluate the progress of hard tissue erosion in teeth coated with two different fluoride-containing enamel varnishes.

MATERIAL AND METHODS

Our study involved 40 teeth with paracervical erosions of dietary origin located on labial and buccal surfaces in 10 dental patients, five women and five men, aged 18-30 years. All patients received oral information about the study and signed their consent to participate in the trial. The study was approved by the Ethics Committee, Medical University of Białystok. All examined individuals completed

aDepartment of Pedodontics, Medical University of Białystok, Poland, bFaculty of Mechanical Engineering, Białystok Technical University, Poland. For correspondence: Dr Danuta Waszkiel, Department of Pedodontics, Medical University of Białystok, 15-274 Białystok, ul. Waszyngtona 15A, Poland. E-mail stdzieci@amb.edu.pl
a questionnaire concerning nutritional preferences, oral hygiene, and tooth brushing habits. Atypical erosions were found both in the maxilla and in the mandible, more frequently on the left (53.6%) than on the right side (46.4%). Patients with enamel erosions consumed citrus fruits, apples, fruit juices, and carbonated drinks. All patients were instructed to eliminate causal factors and to institute anti-destructive procedures. Assessment of dietary habits showed a preference of sour food products in most patients. Most of the patients brushed their teeth three or more times a day using a variety of toothpastes. Five patients cleaned their teeth with circular movements, two brushed with horizontal movements, while three used the toothbrush freely. They all exhibited good oral hygiene.

In the next stage of the experiment, the teeth were isolated from the saliva, mechanically brushed, and impressions were taken using an impression material Express (3M, USA). Next, the teeth were covered with varnishes containing fluoride compounds. Duraphat® varnish was applied to lesions on one side of the dental arch, while Fluoride Protector® was applied on the other side. In each patient, two teeth were varnished three times and the next two six times at two-week intervals. A year after the start of the experiment, the teeth were imprinted again. Blue Express 7301 H models were constructed from these impressions. Erosion progress was measured after one year using our own modification of techniques described by Xhonga et al.¹⁴ and Bishop et al.¹⁵, which allowed repeatability of results. The silicone imprint constructed a year earlier was superimposed on the same tooth model. MaxSil (Rhodia Chem Italy S.p.A) of a contrastive hue was used to fill up the space between the imprint and the model. Dental models were cut in the median line along their long axis. Specimens were then prepared by sawing a 1 mm thick slice from each half and checked under a Universal Measurement Microscope (Carl Zeiss Jena) equipped with a calibrated ocular grid. The inspection of dental cross-sections allowed detection and measurement of sites with the thickest layer of the impression material.

The results were subjected to statistical analysis using the Mann-Whitney test and a statistical pack SPPP. They were considered statistically significant at p<0.05.

**RESULTS**

Enamel loss after three and six varnish applications are given in Table 1. It was found that erosion progression depends on the number of fluoridation procedures. Differences in erosion progression between the three-fold and six-fold varnishing were statistically significant both for Fluoride Protector® (p<0.005) and Duraphat® (p<0.001).

<table>
<thead>
<tr>
<th>No. of applications</th>
<th>Type of varnish</th>
<th>No. of teeth</th>
<th>Erosion progression after a year $\lambda$ (µm)</th>
<th>SD</th>
<th>Daily erosion progression $\lambda$ (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Fluoride Protector®</td>
<td>10</td>
<td>236.6*</td>
<td>63.94</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>Duraphat®</td>
<td>10</td>
<td>268.9†</td>
<td>82.17</td>
<td>0.74</td>
</tr>
<tr>
<td>6</td>
<td>Fluoride Protector®</td>
<td>10</td>
<td>127.2</td>
<td>62.60</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>Duraphat®</td>
<td>10</td>
<td>119.3</td>
<td>65.49</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Compared with three and six applications of varnishes: *p<0.005; †p<0.007.
Table 2 shows erosion progression. It is affected by lesion location. Erosion was significantly more advanced in the upper teeth following three-fold varnishing compared with the lower teeth (p<0.001). The six-fold varnishing provided better protection of enamel surface against the action of acids, although in this case more substantial progression was also observed in the maxilla than in the mandible, the differences being statistically significant (p<0.002).

<table>
<thead>
<tr>
<th>No. of applications</th>
<th>Location</th>
<th>No. of teeth</th>
<th>Erosion progression after a year $(\mu m)$</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Upper teeth</td>
<td>10</td>
<td>297.3*</td>
<td>58.18</td>
</tr>
<tr>
<td></td>
<td>Lower teeth</td>
<td>10</td>
<td>208.2†</td>
<td>60.27</td>
</tr>
<tr>
<td>6</td>
<td>Upper teeth</td>
<td>12</td>
<td>150.9</td>
<td>67.38</td>
</tr>
<tr>
<td></td>
<td>Lower teeth</td>
<td>8</td>
<td>100.1</td>
<td>23.68</td>
</tr>
</tbody>
</table>

Compared with three and six applications of varnishes: *p<0.005; †p<0.007.

**DISCUSSION**

Acid resistance of enamel is determined by its composition and chemical make-up including the content of fluoride ions. The efficacy of exogenous fluoride substances varies according to the type, concentration, and pH of the preparation used. Nowadays, the application of fluoride varnishes, which by inhibiting enamel demineralization play a significant role in caries reduction, is considered the most effective method of fluoride supply. The mechanism of topically applied highly concentrated fluoride involves the dissolution of the most external enamel layers and repeated precipitation of calcium fluoride bound with enamel mainly as $\text{CaF}_2$ or a $\text{CaF}_2$-like compound. These compounds, constituting a fluoride reservoir, are believed to be responsible for the elevated concentration of fluoride ion in the immediate surroundings of teeth.

The varnishes Duraphat® and Fluoride Protector®, commonly available in our country were used in the present study to evaluate the prophylactic effects. Their prophylactic effect was found to depend more on the number of procedures than on the type of varnish. Duraphat® with higher fluoride concentration was more effective in the three-fold application, while the efficacy of Fluoride Protector® increased with an increased number of procedures. Studies of Attin et al. have shown that varnishes with higher fluoride content and an additional amount of calcium fluoride deposit larger amounts of structurally bound fluorides soluble in KOH than varnishes with lower fluoride concentration; however, the differences disappear after a longer time of action.

The mean daily enamel erosion progression after the three-fold application of Duraphat® was reduced after the six-fold treatment. Similar results were obtained using Fluoride Protector®. Xonga et al. evaluated eroded teeth following the application of a commercial 33.33% NaF preparation, compared with untreated teeth. The results showed no significant differences in erosion progress between fluoridated and non-fluoridated teeth, with the mean daily enamel erosion rate being 1 $\mu$m after five months. The data suggest that fluoride preparations *per se* are not able to secure complete protection against erosive factors. They also seem
to indicate that fluoride varnishes are more efficient in preventing enamel dissolution than NaF solutions, which has already been reported in literature.\textsuperscript{19}

Enamel erosion lesions are due to the action of acids which possess stronger demineralization properties than dental caries. Therefore, since topical fluoride preparations that play an important role in caries prophylaxis may not be effective in preventing acid erosion, formulations of varnishes with higher fluoride concentrations should probably be considered for application.

In conclusion, we found: (1) application of fluoride varnishes reduces enamel susceptibility to the action of erosion-inducing factors; (2) the number of varnishing procedures determines the efficacy of varnishes.

REFERENCES