EFFECT OF RESIN MODIFIED GLASS IONOMER CEMENT ON MICROHARDNESS OF INITIAL CARIES LESIONS

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Abstract. Resin modified glass ionomer cement (GIC) can inhibit caries lesion formation directly adjacent to the application site but there are few studies examining the remineralization effects of resin modified GIC at other sites more remote from the application site. We conducted an in vitro study to evaluate the distance at which resin modified GIC is able to exert a remineralization effect on initial caries lesions from the application site. We immersed 60 bovine incisors for 24 hours in lactic acid to create artificial initial caries lesions. These teeth were then randomly divided into 2 groups of 30 teeth per group: Group 1 received no treatment (control group); in Group 2 resin-modified GIC was applied on the labial surface of the tooth. The teeth were then tested for microhardness at distances of 0.5, 1, 2 and 3 mm from where the resin modified GIC was applied. Microhardness was tested in all teeth at baseline, after initial caries lesion formation and after treatment. The mean microhardness at each site at each testing was compared using the one-way analysis of variance (ANOVA) and Tukey comparison tests. Significance was set at $p<0.05$. After treatment, there was no significant change in microhardness value at any site tested in the control group ($p=0.994$). However, in the resin modified GIC group after treatment, all sites tested increased significantly in microhardness ($p<0.05$) and were significantly greater in microhardness than the control group ($p<0.05$). In the resin modified GIC group, the mean microhardness values at 0.5 and 1 mm from the resin modified application site higher than at 2 and 3 mm ($p<0.05$). The mean microhardness values were not significantly different in the treatment group between 0.5 mm and 1 mm and between 2 mm and 3 mm from the application site ($p>0.05$). In this in vitro study, resin-modified GIC provided a remineralization effect on initial caries lesions up to 3 mm from the application site but had its greatest benefit within 1 mm from the application site.

Keywords: resin modified glass ionomer cement, microhardness, remineralization, remote site

INTRODUCTION

Dental caries constitute an international public health problem, especially among young children, who have a higher incidence than adults and among needier populations that do not have access to
curative or preventive treatments (Çolak et al, 2013).

For people with limited access to conventional treatment, Atraumatic Restorative Treatment (ART) such as resin modified glass ionomer (GIC), can be of benefit, especially in communities lacking sophisticated dental equipment or electricity (Smales and Yip, 2002).

GIC is commonly used in restorative dentistry, especially among patients at high caries risk, such as children, and is a choice material for ART due to its fluoride releasing properties and remineralization abilities (Dionysopoulos et al, 2013), which also inhibit demineralization (Dionysopoulos et al, 2016). It is convenient due to its chemical adhesion properties (Nicholson, 2016) and its good biocompatibility to tooth tissues (Rodriguez et al, 2013). Resin modified GIC has greater strength and is less resistant to loss than low viscosity GIC (Mount, 2005).

Several studies (Amaral et al, 2006; Vojinović et al, 2010) have reported demineralization inhibition of normal tooth structure and remineralization of enamel lesions adjacent to GIC application areas but there are few studies of the effect of resin modified GIC in areas near GIC applications. The aim of this study was to investigate effect of resin-modified GIC on the microhardness of teeth on areas around GIC application sites.

MATERIALS AND METHODS

Specimen preparation

Sixty bovine teeth were chosen for this study. The radicular part of each tooth was removed and the tooth was then embedded in self-curing acrylic resin. The enamel side of each tooth specimen was ground flat with 400, 800, 1,000, 1,200, 2,500 and 4,000-grit silicon carbide grinding paper (Buehler, Lake Bluff, IL) with a rotating polishing machine (Grinder-Polisher, Metaserv 2000; Buehler, Lake Bluff, IL). Specimens were stored in deionized water at room temperature until use.

Microhardness determination

Tooth microhardness was measured using a Vicker’s diamond indenter using a 100 gm load for 15 seconds at 4 sites: 0.5, 1, 2, 3 mm from the edge of a 4 mm diameter circle on the tooth (Vongsavan et al, 2016). The microhardness was measured 4 times at each distance described above and the average microhardness for that distance was recorded.

Artificial caries lesion creation

Artificial caries lesions were formed in the enamel of the tooth samples by placing each tooth in 0.1 M lactic acid, 0.2% Carbopol, 4.1 mM CaCl₂·2H₂O, 8.0 mM KH₂PO₄, adjusted to a pH of 5.0 using KOH for 15 hours at 37°C (Lippert et al, 2012).

Microhardness of lesion formation

After demineralization the microhardness of each tooth was again detected in the same manner as the baseline at 0.5, 1, 2, 3 mm from the edge of the 4 mm circle.

Control and treatment groups

The specimens were randomly divided into 2 groups (n=30 each): Group 1: no treatment (control group); Group 2 (treatment group): resin modified GIC (GC Fuji II LC®; GC, Tokyo, Japan) cylinders (4x4 mm in length and 1 mm height) were made in a silicone elastomer mold and placed on specimen in the 4 mm circle described above. Each specimen was then immersed in artificial saliva at 37°C for 7 days (Maneenut et al, 2003).
Table 1
Microhardness of studied bovine teeth by distance from resin modified glass ionomer cement.

<table>
<thead>
<tr>
<th>Distance from resin modified glass ionomer cement application site</th>
<th>Tooth microhardness at baseline, Mean ± SD (VHN)</th>
<th>Tooth microhardness post lesion formation, Mean ± SD (VHN)</th>
<th>Tooth microhardness after treatment, Mean ± SD (VHN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 mm</td>
<td>286.26±15.85aA</td>
<td>90.30±13.35bB</td>
<td>108.97±18.26bC</td>
</tr>
<tr>
<td>1 mm</td>
<td>282.10±19.66aA</td>
<td>92.43±13.72bB</td>
<td>109.05±19.97bC</td>
</tr>
<tr>
<td>2 mm</td>
<td>287.80±15.35aA</td>
<td>90.80±13.24bB</td>
<td>109.17±12.06bC</td>
</tr>
<tr>
<td>3 mm</td>
<td>290.96±12.73aA</td>
<td>92.80±13.82bB</td>
<td>109.55±18.86bC</td>
</tr>
</tbody>
</table>

SD: standard deviation; VHN: Vicker hardness number.
Within columns, differences in lower-case superscript letter letters indicate significant differences by periods (p<0.05).
Within columns, differences in upper-case superscript letter letters indicate significant differences by distance from application sites (p<0.05).

Microhardness determination
The tooth microhardness was again measured at the same distance from the circle as mentioned previously.

Statistical analysis
The mean sample microhardness at each distance and at each period was calculated. These were then compared using the one-way analysis of variance (ANOVA) and Tukey multiple comparison tests. The computer program SPSS version 18.0 software for Windows (Statistical Package, for the Social Science; IBM, Armonk, NY) was used for data analysis.

RESULTS
The means and standard deviations for sample microhardness at baseline, post-lesion formation and post-treatment are shown in Table 1. There was no significant difference in microhardness values at baseline at any of the sites tested (p=0.988).

Post-lesion formation, there was no significant difference in microhardness at any of the sites tested (p=0.874) but compared to baseline, all the teeth had significantly lower microhardness (p=0.008).

After treatment, there was no significant change in microhardness at any of the sites in the control group (p=0.994) compared to post-lesion formation but in the treatment group (Group 2) there was a significant increase in microhardness at all sites (p<0.05). The microhardness post-treatment was significantly greater in the treatment group (Group 2) than in the control group (Group 1) (p<0.05). In the treatment group (Group 2), the mean microhardness values at 0.5 and 1 mm were significantly higher than at 2 and 3 mm (p<0.05). However, in the treatment group (Group 2) there were no significant differences in microhardness between 0.5 and 1 mm and between 2 and 3 mm (p>0.05).
DISCUSSION

Resin modified GIC was more effective than the control group in our study to assist in tooth remineralization, as seen in previous studies (Jang et al., 2001; Vermeersch et al., 2001). GIC has anticariogenic properties (Tay, 1995) and can inhibit demineralization of teeth around application areas, which is thought to be due to its fluoride release (Reteif et al., 1984; Mickenautsch and Yengopal, 2010). In addition to preventing demineralization, GIC used to fill caries in teeth has been found to more effectively prevent well lesions than teeth filled with composite and amalgam (Dionysopoulos et al., 1994). Fluoride released from GIC has been found to be acquired by enamel and cementum as far as 7.0 mm from the application site (Retief et al., 1984; Tantbirojn et al., 1997). In our study, we found a remineralization effect up to 3 mm from the application site.

Tantbirojn et al. (1997) reported the inhibitive effect of enamel demineralization of resin modified GIC was greatest within 1.0 mm of the application site, similar to our findings. This is most likely because the concentration of fluoride is the greatest within 1 mm of the application site (Ferracane et al., 1998).

Resin modified GIC has a remineralization effect on initial caries lesions up to 3 mm from the application site, but is greatest within 1.0 mm of the application site.

REFERENCES


Nicholson JW. Adhesion of glass-ionomer


