

MICROLEAKAGE OF THREE COMPOMERS RESTORATIVE MATERIALS IN BOVINE INCISORS

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كان الهدف من هذا البحث هو تقييم التسرب الدقيق لثلاث مواد من الكومبومر وهي: إف ٢٠٠٠, دايراكست وهايتاك ومقارنتها بمادة الراتنج الترميمية (زي ١٠٠). في هذه التجربة تم استخدام أسنان بقر (القواطع) ، حيث جرى حفرها بطريقة معينة في ملتقى آلمينا بالملاط في الجدار الدهليزي لكل سن، ثم قسمت الأسنان بطريقة عشوائية إلى أربع مجموعات بحيث يتم استخدام عشرة حشوات من كل مادة. وبعد وضع الحشوات في الأسنان، حسب التعليمات المصاحبة لكل مادة، تم طلاء الأسنان بصيغة الفيوشين بقوة (٢٠%) ما عدى ١ ملم من الحواف، وبعد أربعة وعشرون ساعة، تم غسل الأسنان ثم قصت طولياً ثم تم تقييم مدى التسرب باستخدام المجهر المضخم. ولقد أظهرت النتائج أن جميع مواد الكومبومر و مادة الراتنج المستخدمة في هذا البحث لم توفر حماية كاملة من التسرب، فمادة إف ٢٠٠٠ أعطت حماية من التسرب في الحواف القاطعة أفضل من مواد الكومبومر الأخرى، وعلى العكس فعند الحواف العنقية كانت كمية التسرب أكبر من مواد الكومبومر الأخرى. وعند مقارنة نتائج التسرب لمادتي إف ٢٠٠٠ ومادة الراتنج (زي ١٠٠) في أسنان البقر مع نتائج التسرب لنفس المادتين في القواطع البشرية، لم تلاحظ أية فروقات، مما يدل على جدوى استبدال الأسنان البشرية بأسنان البقر عند إجراء دراسة الالتصاق والتسرب.

The microleakage of three compomers restorative materials (Hytac, Dyract and F2000) was evaluated and compared to that of Z 100 composite resin. Ten restorations from each material were placed in Class V cavities in bovine incisors according to manufacturer's instructions. All cavities were prepared with 90-degree cavosurface margins and were located at the cemento-enamel junction. After immersion in 2% basic fuchsin dye, the teeth were sectioned longitudinally in a bucco-lingual direction using a diamond saw. Each section was then inspected under a stereomicroscope. Microleakage in human teeth using one compomer and Z 100 composite resin was also determined. The results showed that the three compomers had different microleakage behavior or the composite resin completely prevented microleakage. At the incisal wall F2000 showed better seal than the other two compomers. However, F2000 showed significantly lesser seal at the gingival wall than Z100 and Dyract. When microleakage results of F2000 and Z100 in bovine and human teeth were compared, no significant difference was found. This indicated the reliability of using bovine teeth in microleakage studies.

Introduction

Compomers or polyacid modified resin composites were commercially introduced in Europe in 1993/1994.¹ They combine the properties of both composite and glass ionomer cements, however, they are more chemically related to composite resins. Compomers contain either or both of the essential components of a glass-ionomer cement (reactive ion-releasing fluorosilicate glass particles and acidic monomer) but at levels insufficient to promote the acid-base reaction in the dark.⁴ Consequently, the setting reaction is principally

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a light-curing mechanism where the initial cross-linking of the methacrylate groups takes place. The acid-base reaction or the ionic reaction between the acid groups on the polymer and the glass occurs at a later stage as water is absorbed from the environment.³ Because of the time delay in the acid-base reaction, no self-adhesion to the tooth substance can be observed. Adhesion to enamel and dentin is achieved by micromechanical retention through the hybrid layer using self-conditioning adhesive.⁴

Because of their better physical properties, better resistance to early moisture contamination, and greater wear resistance relative to the conventional glass ionomers, compomers have received considerable attention.⁵ Several studies found that the bond

strength of compomers to enamel and dentin range far beyond those of glass ionomer.^{6,7} Moreover, some studies reported marginal quality of compomers in dentin equivalent to that with composite.^{8,9}

The aims of this study were to evaluate the marginal seal of three compomers in comparison to composite resin using bovine incisors and to compare the microleakage in bovine and human teeth using one compomer restorative material and one composite resin.

Materials And Methods

Twenty bovine incisors which had been stored in 1% sodium hypochlorite at room temperature were used. After debridement with a brush, they were cleaned with rubber cup and fluoride free pumice. Class V cavity preparations were cut in the buccal and lingual surfaces of all teeth. The preparations were 5 mm long, 3 mm wide and 2 mm deep with the incisal walls in enamel and the gingival walls in dentin/cementum. The preparations were cut using 330 carbide bur (Midwest Dental Product Corp., Des Plaines IL, USA) in a high speed hand piece with water spray. The teeth were then randomly assigned to four groups; each group contained ten restorations. All teeth were restored according to manufacturer's instructions.

Cavities in Group I were restored with Hytac OSB (ESPE, GmbH Seefeld, Germany). Hytac OSB (primer/adhesive) was applied with a brush to the entire cavity then it was rubbed for 30 seconds. Excess liquid was removed with oil free air and light cured for 10 seconds. Second coat of Hytac OSB was applied and immediately spread with air then light cured for 10 seconds. After applying the primer/adhesive, the cavities were restored with Hytac Aplitip and the restorations were light cured for 40 seconds.

Group II was restored with F2000 (3M Dental Products St. Paul, MN, USA). F2000 primer/adhesive was applied to enamel and dentin for 30 seconds, gently air dried for 5-10 seconds and light cured for 10 seconds. The F2000 restorative material was then placed in increments and each increment was light cured for 40 seconds.

Group III was restored with Dyract (Dentsply De Trey GmbH). The adhesion promoting monomer of Dyract, (PSA primer/adhesive) was applied with a brush to the exposed dentin to thoroughly wet the surfaces. The primer was left undisturbed for 30 seconds and the excess was removed by a gentle stream of air. After drying, the primer was light cured for 10 seconds. A second layer of the PSA primer/adhesive was applied and the light curing was repeated for 10 seconds. Dyract restorative was immediately placed over the cured PSA primer/adhesive in increments and each increment was light cured for 40 seconds.

Group IV, which served as control, was restored with Z100 composite resin (3M Dental Products, St Paul, MN). A Scotchbond Multi-purpose etching gel was applied for 30 seconds to remove the smear layer and to modify the enamel and dentin substrates. The cavity was then rinsed with water spray for 30 seconds and dried gently. The primer was applied to the whole cavity walls with a soaked cotton pellet for 30 seconds, followed by gentle air-drying. The bonding resin was then applied and light cured for 20 seconds. The composite resin was placed in increments, and each increment was light cured for 40 seconds. Immediately after placement of the last increments from each restorative material and before light curing, a clear matrix was placed to give contour to the restorations. All restorations were finished and polished using Sof-Lex discs (3M Co.).

The teeth apices were sealed with light-activated composite. The teeth were coated with nail varnish except for 1 mm around the restoration margins. The samples were then immersed in 2% basic fuchsin dye (Fisher Scientific, Fair Lawn, NJ, USA) for 24 hours at the room temperature. Before sectioning, the teeth were thoroughly washed with water to remove the superficial dye. Each tooth was sectioned longitudinally in a bucco-lingual direction with a low speed water-cooled diamond saw (Silverstone-Taylor Hard Tissue Microtome, Scientific Fabrication, Littleton, CO., USA). Each section was inspected under a stereomicroscope (Wild Photomakroskop M400, Heerbrugg, Switzerland) at 32x magnifications. The staining along the tooth restoration interface was recorded according to the following criteria:¹⁰

- 0- No evidence of dye penetration at tooth/restoration interface
- 1- Dye penetration along the interface < half the depth of the cavity
- 2- Dye penetration to full depth of the cavity but not involving the axial wall
- 3- Dye penetration along the axial wall

Comparing Microleakage in Bovine and Human Teeth

In order to check the reliability of using bovine teeth as a substitute to human teeth in this study, an experiment was conducted to compare microleakage in human and bovine teeth using F2000 compomer restorative material and Z100 composite resin.

Ten extracted human incisors, were cleaned with flour of pumice using a rubber cup at slow speed. Class V cavity preparations were made on the buccal and lingual surfaces of the teeth with similar dimensions to the bovine teeth. The teeth were randomly assigned to two groups; each group contained ten cavities. The first group was restored with F2000 and the second group with Z100 according to manufacturer's instructions and as previously described. The teeth were then exposed to microleakage testing as mentioned before.

Statistical Analysis

The data were analyzed using Kruskal-Wallis one-way analysis of variance test to identify any significant differences between the various restorative materials. Combined incisal and cervical scores within each restoration were compared using Wilcoxon matched pairs signed rank test.

Results

Microleakage in Bovine Teeth

The microleakage scores at the incisal and gingival walls in bovine teeth are presented in Table 1. Kruskal-Wallis one-way analysis of variance indicated significant differences between the restorative materials at the incisal and the gingival walls ($P > 0.05$). Tukey's multiple comparison, using Nemeni test, indicated that Dyract and Hytac had significantly higher leakage at the incisal walls than Z100 and F2000. On the other hand, F2000 had significantly higher leakage at the gingival walls than

Z100 and Dyract, while no significant difference was found between F2000 and Hytac.

Wilcoxon matched-pairs signed-rank test for comparing incisal and gingival scores for each material showed significant differences between the incisal and gingival walls of F2000 and Dyract. Significantly better seal at the incisal walls was recorded for F2000. On the other hand, Dyract showed significantly better seal at the gingival walls. No significant difference was found between the incisal and gingival walls for Z100 and Hytac.

Microleakage in Human Teeth

The microleakage scores at the incisal and gingival walls in human teeth are presented in Table 2. Kruskal-Wallis one-way analysis of variance indicated no significant differences between F2000 and Z100 in human teeth at both walls. Furthermore, Wilcoxon matched-pairs signed-rank test for comparing incisal and gingival scores for each material did not indicate any significant difference.

When the incisal and the gingival microleakage scores for F2000 and Z100 in bovine teeth were compared with their corresponding walls in human teeth, Kruskal-Wallis one-way analysis of variance indicated no significant difference. However, Wilcoxon matched-pairs signed-rank test indicated that F2000 in bovine teeth showed significantly higher leakage at the gingival walls than the incisal walls. However, in human teeth F2000 showed no significant difference between the two walls.

Discussion

The three compomer restorative materials (Hytac, F2000, and Dyract) and the composite resin (Z100) exhibited variable results in the microleakage test. Hytac and Z100 composite resin showed consistent marginal seal at both walls. Significantly better marginal seal at the enamel walls than at dentin / cementum walls was recorded for F2000. This result corresponds to other studies, which have investigated the marginal seal of compomers and resin modified glass ionomers.¹¹⁻¹² On the other hand, Dyract had significantly more reliable seal at the gingival walls than the incisal

walls. Dyract marginal seal showed varying results in the literature. Some studies found that Dyract had poor marginal seal at the cervical margins,¹² others obtained a very good marginal seal at both walls.¹³ The poor marginal seal of Dyract at the enamel walls, noticed in this study, might be due to significant interaction between the material and margin type; dentin has higher water content than enamel, which might facilitate the adhesion of Dyract to dentin and subsequently improves the marginal seal. Brackett et al¹² suggested enamel beveling and etching before application of Dyract primer/adhesive. Others found the use of enamel-dentin bonding agents significantly reduced the marginal leakage.¹⁴

None of the three compomers or the composite resin completely eliminated microleakage in all samples. It is well known that compomers exhibit a close chemical kinship to composite resins and their vulnerable bonding is often disrupted by the strong contraction stresses developed during curing.¹⁵ During the setting reaction of these materials, there is a consequence of repulsive forces between the individual monomer molecules and the reduction in these repulsive forces, when monomer molecules join together to form polymers, results in polymerization shrinkage.¹⁶ Therefore, the different sealing ability of the three compomers can be explained by the difference in their shrinkage rate and the degree of shrinkage that subsequently depends on the filler type, size and coating for each material. In addition, the shrinkage rate depends on the monomer system, the concentration of the catalyst and or the initiating system of each material which determine the structure and density of its polymer network.¹⁵

When the marginal seal of F2000 and Z100 composite resin in bovine teeth was compared to that in human teeth, no significant difference was found in both margins. The only significant difference was found for each material when the incisal and gingival walls were compared. F2000 in bovine teeth showed significantly better seal at the enamel than at the dentine/cementum walls. On the other hand, F2000 in human teeth showed no significant

difference in marginal seal in both walls. This finding may indicate that bovine teeth undergo slightly more leakage than human teeth, which agrees with the results of other studies.¹⁷ However, bovine teeth have become a popular substitute for human teeth in studying microleakage and adhesive dental materials.

Since microleakage was not completely eliminated with any of the restorative materials used in this study, it is important to consider the anticariogenic properties of compomers over composite resins. Compomers might be indicated in restoring esthetic areas during caries control, especially in shallow cavities where glass ionomer / composite sandwich

Table 1. Microleakage scores of the three compomer restorative materials at the incisal and gingival margins.

Material	Microleakage scores at the incisal margin				Microleakage scores at the gingival margin					
	No.	Scores			No.	Scores				
		0	1	2	3		0	1	2	3
Hytac	20	10	10	0	0	20	14	6	0	0
F2000	20	17	3	0	0	20	7	7	4	2
Dyract	20	9	9	2	0	20	18	2	0	0
Z100	20	16	4	0	0	20	19	1	0	0

Table 2. Comparing microleakage of the restorative materials in bovine and human teeth.

Material	Microleakage scores at the incisal margin				Microleakage scores at the gingival margin					
	NO.	Scores			No.	Scores				
		0	1	2	3		0	1	2	3
Hytac	20	10	10	0	0	20	14	6	0	0
F2000	20	17	3	0	0	20	7	7	4	2
Dyract	20	9	9	2	0	20	18	2	0	0
Z100	20	16	4	0	0	20	19	1	0	0

technique can not be used. Fluoride release and its uptake by the tooth structure could significantly decrease the potential for secondary caries.¹⁸

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