Microleakage of class V composite restorations prepared conventionally with those prepared with an Er:YAG laser: a pilot study

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Introduction

Since the advent of acid etching, composite resin technology has improved.[1] Composite resins are bonded mechanically to acid-etched enamel, relying on a large interlocking area between the two to form an effective bond. Bonding of composite resin to dentin is attained by chemical means, either to the organic or inorganic part of the dentin. Polymerization shrinkage, however, still plagues the longevity of direct resin restoration.[1, 2] Although the mechanical bond with enamel is sufficiently strong to withstand this contraction, the same cannot be said for the dentin. The result is marginal leakage at the junction of the composite resin and dentinal margin.[3] Past experiments demonstrating leakage are performed with conventional high-speed drilling and acid etching either with gel or liquid.

None of the traditional restorative materials used in dentistry provide adhesion to tooth structure.[5] Thus a microscopic space always exists between the restoration and prepared cavity. Staining, which sometimes is seen at the margin of resin restorations, is caused by the penetration of substances or their degradation products into these microspaces at the resin restoration-tooth interface. Although some of the newer restorative materials, such as those systems based upon polyacrylic acid and possibly certain dentin bonding resin systems, have significantly reduced the microspaces, gaps may occur as a result of the material. Many materials shrink on setting, creating a gap at the tooth-restorative interface.

The Er:YAG laser (Aesculap Meditec—Heroldsberg, Germany) currently is undergoing clinical trials in Europe that are directed toward cutting efficiency and patient comfort.[4] Little information is available as to the quality of the restoration when the cavity preparation is prepared by and etched with an Er:YAG laser. The purpose of this paper is to compare microleakage when cavity preparations are prepared conventionally with a high-speed drill and acid etched or prepared and etched with an Er:YAG laser.

Methods and materials

Fifteen previously extracted human molar teeth, which had been stored in water, were divided equally into three groups and prepared for class V resin restorations to a depth of approximately 1 mm into dentin. Group 1 was prepared with a conventional high-speed drill and acid etched with a 37% phosphoric acid gel. Group 2 also was prepared with a conventional high-speed drill and #330 carbide bur, but the enamel cavosurface was etched with the Er:YAG laser. Group 3 was prepared and etched with the Er:YAG laser.

The Er:YAG laser with a wave length of 2.94 µm was used for the experimental preparations and etching. Preparations were initiated with 300 µJ of energy at 2 pulses per sec and the energy level was adjusted as necessary. During the cavity preparations, the laser energy was adjusted slightly to maximize cutting efficiency. All preparations required approximately 300 ± 50 pulses maintaining 2 pulses per sec. Preparations were made approximately 1 mm past the dentinoenamel junction. During the preparation, dentinal cutting was evident by the sound: since dentin ablates easier than enamel, there is a louder "popping" noise when cutting into the dentin. For etching enamel, energy was decreased to 200 µJ. Since the Er:YAG laser is strongly absorbed by water, all treatments performed with it in this experiment used a water spray.

All class V restorations were restored with Prismafil™ (LD Caulk—Milford, DE) according to the manufacturer's instructions, following application of the bonding agent before inserting the filled resin. Following restoration, the specimens were stored in sterile water for 90 days with the water being changed every 24 to 48 hr. After the storage period, specimens were immersed in a 50% silver nitrate solution for 24 hr. Sectioning was carried out using an Isomet Saw (Accutom—Struers, Denmark). Slices 0.1 mm thick were cut in a horizontal plane to the occlusal surface of the tooth. All sections then were stored in distilled water for sectioning.

All sections were photographed for slides at a standardized distance. Slides were projected and evaluated according to the following criteria: 0 = no leakage, 1 = leakage into the enamel but not past the dentinoenamel junction, 2 = leakage into the dentin but not to the pulpal or axial floor, and 3 = leakage to the pulpal or axial floor.[5] Specimens were evaluated by three examiners. If any disagreement in evaluation occurred, it was discussed until there was a consensus.

Results

The microleakage results for this investigation are

Table. A comparison of marginal leakage for the three groups of Class V restorations

Group	*Microleakage*			
	0	1	2	3
Group 1	B D E	A	—	C
Group 2	B D E	C	—	A
Group 3	C D E	A	B	—

0 = no leakage; 1 = leakage to the dentinoenamel junction; 2 = leakage into dentin, not to axial wall; 3 = leakage into dentin and to axial wall; A–E are teeth # in each group.

summarized in the Table. Kruskal-Wallis, a nonparametric test, demonstrated no significant difference on these samples ($P = 0.99$). Note too, that in each group three specimens showed no marginal leakage.

Discussion

The preparation and treatment of the tooth also influences the microspace between tooth and restorative material. The cavosurface margin produced by the Er:YAG laser preparation appears quite rough in comparison to the enamel margin produced by conventional high-speed cutting. Consequently, the margin could result in increased microspacing and greater microleakage. On the other hand, the converse also is possible since the rougher surface might provide improved mechanical bonding. Thus the quality of the restoration produced using an Er:YAG laser deserved investigation.

Radioisotope tracers, dyes, and scanning electron microscopy have been used to demonstrate the penetration of fluids and oral debris along the interface between the restoration and the tooth. In this preliminary investigation, dyes were used and the results indicated that preparation and etching with an Er:YAG laser does not adversely influence the microleakage surrounding the restoration. The microleakage results suggest that the laser technology could be submitted for traditional techniques. This is a preliminary investigation, however, and further study is planned using greater sample sizes with thermocycling, larger restorations, and cavity liners.

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