SCANNING ELECTRON MICROSCOPIC STUDY FOR THE EFFECT OF SELF-ETCHING ADHESIVE SYSTEMS ON DIFFERENT SMEAR TYPES FOR RESIN COMPOSITE BONDING

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Introduction

Cutting of tooth tissues is performed by rotary tools (burs and abrasives), air abrasion, ultrasonic or by laser. Tooth preparation by air-abrasion is reported to offer improved patient comfort by eliminating the heat, vibration and noise associated with rotational method. It may allow tooth preparation with less need for local anesthesia. This also enhances the ability of treating teeth for different compromised patients. It also gives great pleasure for both patient and dentist due to decreased dental chair-side time (**Wright et al, 1999**). However, cutting of tooth structure creates a tenaciously adherent layer on the surface that is termed smear layer. This letter designates an amorphous layer of organic and inorganic debris, that occludes the dentinal tubules and cannot be removed by the ordinary water spray (**Pashley, 1984**). Moreover, it is well known that the quality and the quantity of the smear layer vary widely depending on the manner in which they were created (**Gilboe et al, 1980**).

Bonding to tooth tissues particularly dentin could be optimized by removal or alteration of this smear layer with conditioners such as acidic solutions (**Toida et al, 1995**). Dentin bonding systems were originally formulated with separate etchants, primers and adhesives, but have evolved in such a way that all three are combined into a single component in some products. Combined or self-etching bonding systems are likely to be popular because of the reduced number of steps necessary prior to the placement of resin composites (**Hannig et al, 1999; Hannig and Bott, 2001; Oberlander et al, 2001** and **Brackett et al, 2002**).

Self etching systems also tried to solve some difficulties commonly associated with the clinical application of etch and rinse systems. As there application procedure is considered less time-consuming and, more importantly, they are less technique-sensitive (**Sono et al, 1999**).

The bonding mechanism of self etching bonding systems is based upon changing the composition of the substrate surface. So, dentin surface is partially demineralized and the resultant porosity filled by resin without a separate rising step (**Inoue et al, 2000**). Self etching primers contain an acidic resin monomer that simultaneously modifies or dissolves the smear layer and selectively demineralize the enamel and dentin surfaces (**Watanabe et al, 1994**) but, some of smear layers could not be completely penetrated by self-etching primers as they have different diffusibility which may compromise demineralization of the underlying dentin and further penetration of the bonding resin into the demineralized dentin (**Ogata et al, 2002**).

Information about the smear layer thicknesses formed by high-speed burs or air abrasion would be essential to determine the type of the bonding system that should be employed and used accordingly. Therefore, the present investigation was targeted to study the effect of tow (one-step) self-etching bonding systems having different pH values and a separate etching bonding system on the dentin smear layers of different thicknesses.

Review of literature

Cutting of hard dental tissues is performed by many tools e.g. burs, air-abrasion or by laser. Air-abrasion technique was developed in response to the need to increase patient comfort by reducing pressure, heat, vibration and noise associated with mechanical preparation of teeth by a rotating bur (**Black, 1945**).

Laurell & Hess (1995) used scanning electron microscopy to compare preparations made with high-speed burs to those made using kinetic energy. They used extracted human teeth in which class V buccal preparation were made using carbide bur at 400.000 rpm or kinetic cavity preparations were attempted using different combinations of aluminum oxide particle sizes and delivery pressures. Each tooth was split, air dried, mounted, coated with gold-palladium and examined using scanning electron microscope. They found that cavities made with high-speed burs had flat, striated, well defined walls and sharp cavosurface margins that exhibited micro-chipping and cracking. In contrast, cavities made with kinetic energy had rounded cavosurface margins and internal line angles, a halo of abraded enamel surrounding the cavities outline, microscopic roughness of the treated enamel and dentin surfaces and apparent closure of dentinal tubules.

Christensen (1996) compared cavity preparation using burs, diamond coated rotary instruments and aluminum oxide particles under air pressure. He stated that cutting with burs or diamond offered precision cutting with considerable control and tactile perception of the extent of the cutting. In the same time it caused pain, vibration, noise and overcutting is easy if the operator loses control. Dull burs produced heat and potential dental pulp damage and the water lavage was necessary for lubricating the cutting instrument and for cooling the tooth surface. On the other hand, removing tooth structure by air abrasion caused less pain, noise and no vibration. He considered it a more useful technique for children compared to rotary handpiece and it explored incipient carious lesions extremely well. It adapted well to certain preparations. He denoted that the cost of air abrasion units was relatively high. He considered that the air adhesive techniques and devices were still in developmental stages and more research and development is to be accomplished to bring the concept to maturity.

Hein et al (1997) compared the different air abrasive units included the Micro Prep Director+, Abradent, Mach 5.0, Micadent, Micro Prep Associate+, Micro Prep Producer, Prep Jet KCP 5, Prep Star, Whisper Jet KCP 100 and Whisper Jet KCP 1000. Controlled cutting test found that the Micro Prep Director+ was the fast cutting instrument. On the other hand, the Micro Prep Producer was the slowest cutting instrument and the other instruments ranged in between them. Concerning the tip diameters and handpiece head sizes, it was found that the KCP, Micro Prep and Prep Star units had best tip deigns that provide the best visibility and accessibility. The Mach 5.0, Abradent and Micadent tips were too short and the heads were too wide for good visibility and access during treatment. As for the power delivery rate, the Micro Prep Director+ consistently delivered the most powder. All units showed some inconsistencies in powder delivery and all had some initial puff of powder upon activation. They also denoted that the majority of air abrasive unit manufacturers filters and dryers to treat the incoming air from either an internal air compressor or office air compressor supply. Moisture contamination in the air lines of air abrasive units was found to cause malfunctions of feed mechanisms and clog air lines. According to the use of air abrasive units, they found that all units tested were useable for cutting preparations and modifying tooth surfaces.