Correlation between number, distribution of voids of the adhesive layers and gap formation of adhesive-tooth interface

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Dedication

To the soul of my dear father **:** who taught me the principles that guide me through my life. I hope he is proud of me.

To my dear mother **:** who without her help I could not finish my work.

To my dear loving husband **:** for his patience and support throughout my work

To my son : the real smile in my life

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Introduction:

Since Buonocore introduced the acid-etching technique, which renders a tooth, surface more receptive for adhesion (Buonocore, 1955), major developments that have improved dentistry have occurred. The development of adhesive resin has changed the design of cavity preparations, replacing the extensive removal of tooth structure (Black, 1917) by more conservative preparation (Fusayama, 1980).

Although adhesion to phosphoric acid–etched enamel is reliable and long –lasting, adhesion to dentin has been far more challenging because of the complex mineral and organic phases of dentin. The bonding mechanism of adhesive resin to dentin proposed by Nakabyashi[1982] was described as micromechanical due to the impregnation and polymerization in situ of monomers into the exposed collagen of demineralized dentin surfaces, creating a hybrid layer (Nakabayashi, 1982) which has been suggested as the main mechanism of adhesion between the adhesive system and conditioned dentin (Walshaw & McComb, 1996).

Even though some of the problems of resin composites, for example, unacceptably low wear resistance,

have been overcome, composites still shrink 2-to-4% upon polymerization (Cook et al, 1999; Park et al, 1999 and Watts DC & al Hindi A, 1999). Shrinkage may cause polymerization stress and/ or gap formation and microleakage depending on the strength with which the composite is bonded to the tooth surface (Davidson et al, $1984_{(a)}$ and Davidson & de Gee, $1984_{(b)}$). These phenomena may lead to postoperative sensitivity, secondary caries and pulpal inflammation.

To improve the marginal sealing of a composite restoration, the use of new-generation dentin bonding agents (Chan KC & Swift EJ, 1994; Goracci et al, 1995 and Nakabayashi N & Saimi Y, 1996) have been proposed to reduce but did not completely eliminate microleakage.

Although many commercially adhesive resin systems are available, there are two major simplified approaches to producing good hybridization and adequate dentin bonds (Van Meerbeek et al, 1998). The first is the total-etching technique, followed by the application of a one-bottle solution containing the primer and the adhesive resin to the moist dentin (Kanca, 1991; Gwinnett, 1992; Kanca, $1992_{(a)(b)}$). The second approach is the self-etching priming

technique which simultaneously conditions both enamel and dentin using an acidic primer, followed by the application of an adhesive resin to the conditioned dentin surface (Chigira et al, 1994; Watanabe et al, 1994). Both approaches have lead to increased bond strengths by preventing the collapse of the deminerlized dentin and producing a well-infiltrated hybrid layer.

A number of papers have evaluated the role of the elasticity of the hybrid layer and/ or adhesive resin layer in relieving the polymerization stress of resin composite (Van Meerbeek et al, 1993).

Concern remains that thin hybrid layers may not provide as much stress- breaking function as thicker hybrid layers. However, one possible solution is to use thicker adhesive layers on top of thin hybrid layers.

One verses multiple application of adhesive layer

Swift et al (1997), evaluated the effect of multiple applications of the one-bottle adhesives Prime & Bond, One-Step, and Tenure Quik on the shear bond strength of composite to dentin. The adhesive systems were bonded to the occlusal dentin of extracted human teeth. Control group specimens received only two applications of adhesive, as recommended by the manufacturers. Two experimental groups of each system received a greater number of adhesive applications.

They found that the mean shear bond strength of the Prime & Bond control group was significantly greater than that of the other two control groups. Multiple applications of adhesive decreased the bond strength of each system, but the difference was significant only for four applications of One-Step. Prime & Bond had significantly higher shear bond strengths to dentin than either One-Step or Tenure Quik.

Choi et al (2000), measured the change in polymerization contraction stress of bonded composite as the thickness of the resin adhesive was systematically varied, and correlate the effects of the adhesive thickness and reduced