Dentinal Microleakage of A Universal Adhesive:

The Effect of Bonding Technique and Dentin Surface Condition

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بسم الله الرحمن الرحيم
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Dedication

To my beloved family;

My mum, my dad, Rami, Eman , Manar and beautiful nieces. You sincerely light my path and bless every step. Thank you for your unconditioned love and devotion. No matter what I say, no words of gratitude would be enough.

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List of Abbreviations

Abbreviation (Acronym)	Synonym
ERA	Etch-and-rinse adhesive
SEA	Self-etch adhesive
UA	Universal Adhesive
Hap	Hydroxyapatite
HEMA	Two hydroxyethyl methacrylate
10-MDP	10-methacryloyloxydecyl dihydrogenphosphate
4-MET	4-methacryloyloxyethyl trimellitic acid
Phenyl-P	2-(methacryloyloxyethyl)phenyl hydrogenphosphate
MMP	Matrix metalloproteinases
Bis-GMA	Bisphenol A diglycidyl methacrylate
Bis-HPPP	Bis-hydroxy-propoxy-phenylpropane
TEGDMA	Triethylene glycol dimethacrylate
Bis-EMA	Ethoxylated bisphenol A glycol dimethacrylate
PEGDMA	Polyethylene glycol dimethacrylate

INTRODUCTION

Long ago, the enamel-resin bond had been proven to be durable. But, this is not the case with dentin. Achieving and maintaining the critical dentinal peripheral seal is pivotal to the durability of composite restorations. This partially depends on comprehensive understanding and proper application of manufacturer's instructions of the used adhesive.

The conception of the "proper protocol" became a huge mental burden for most dental practitioners due to the diversity of products and the associated manufacturers' instructions. So manufacturers are directed towards simplifying bonding protocols. Simplified protocols became a valuable quality of the adhesives, fortunately, provided by the multi-mode or universal adhesives. These adhesives have the chemical advantage of bonding effectively to all substrates, with all bonding techniques and on all dentin surface conditions. Being multi-mode, they provide simplicity and user-friendliness. However, we now realize that this advantage is on the expense of the long term performance of the adhesive. By far, long-term durability of Universal Adhesives as most simplified adhesives is not yet established[1].

The long-term sealing ability and performance of any adhesive should be thoroughly tested. To simulate the clinical situation, the adhesive is put in a surrogate state to that of the oral condition as much as possible as. That way, specified parameter(s)' effect on the adhesive performance can be assessed. Artificial aging is expected to decrease the bonding effectiveness and compromise the critical marginal seal. Moreover, in the actual dynamic oral environment, the adhesive is

supposed to survive all chemical, mechanical and physical parameters and maintain the integrity of the interface.

The paradox in the multiple abilities of universal adhesives to bond effectively with different bonding techniques, to different dentin surface conditions and to different substrates are attributed to its chemical structure; mainly presence of hydrophilic acidic [2] and other [3] monomers and silane coupling agent [1], all of which are hydrolytically unstable, in addition to high water and solvent content[4]. The immediate and short term sealing ability of this newly developed adhesive have been established for some products. Therefore, it was found beneficial to evaluate maintenance of this sealing ability on the long term and whether it would yield different results when used in different modes, under different surface wetness conditions of the substrate after long-term water storage.

REVIEW OF LITERATURE

The continuous breakthroughs in adhesion science and evolution of dental adhesives had recently led to less technique sensitivity, user friendliness and less chair-time [5,6,7,8,9]. All-in-one adhesives spread in the market and used extensively for their less application time, and reduce the possibility of iatrogenic errors in clinical manipulation during etching, rinsing and drying[6]. They include, one-step self-etch adhesives, and the universal or multi-mode adhesives that were recently launched in the market[10]. Dentists strive for a durable adhesive beside the fore-mentioned advantages. And the ultimate goal of good adhesion remains to produce an interface that is strong and durable[11] and with a good marginal seal as well[12]. Unfortunately, most recent adhesives are not as durable as they were assigned to be[2]; consequently, the marginal seal is affected over time. In order to simplify the application steps, manufacturers added the ionic resin monomers with acidic phosphate or carboxylic functional groups, hydrophilic monomers, hydrophobic monomers, water and organic polar solvents in a single bottle [5, 7, 12, 13]. This one-bottled complex chemistry became more hydrophilic [3, 14]. Still, the three-step etch-and-rinse adhesives are considered as the gold standard in terms of durability [12, 15, 16, 17], and still the bonded interface is considered the weakest area of tooth-colored restorations [15, 18, 19]. Clinically, marginal deterioration of composite restorations remains however problematic in the long term and still forms the major reason to replace adhesive restorations[20]. The durability of the adhesive/dentin bond is directly related to the quality of the hybrid layer that connects the bulk adhesive to the subjacent intact dentin [21]. A well-formed interface should have minimal imperfections. Ideally, the adhesive