A review of dentin adhesives in pediatric dentistry

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ABSTRACT Evolution of the different generations of dentin adhesives has been based on extensive clinical and laboratory research, which recognizes the problems related to bonding properties. The purpose of this paper is to provide an update on the current development in dentin adhesives. Special consideration is given to bonding to dentin in primary teeth and the clinical application of adhesives in pediatric dentistry.

Key words: Adhesives; Dentin; Pediatric dentistry; Tooth, deciduous

Introduction

Dentin adhesives are used to bond resin composites to the surfaces of the dentin via micromechanical retention. The resultant mechanical sealing of the exposed dentin tubules by the adhesive resin is one of the mechanisms that accounts for the low levels of pulpal irritation. Bonding composites to dentin have the advantage of eliminating or reducing marginal leakage, reducing recurrent decay and maintaining tooth structure with more conservative cavity preparations. The majority of dentin adhesives are based on bi- or multi-functional molecules, which contain reactive groups that interact with the organic and/or inorganic components of dentin and the monomer of the composite resin 1.

Compared to the success of bonding to enamel, because of its hydrated nature, dentin bonding is much more difficult and clinically far more challenging. Unlike enamel, which is the most highly mineralized tissue known, dentin has a more complex histological structure. Dentin is a porous, fluid-filled mineralized tissue that contains approximately water (20%), organic materials (mostly type I collagen) (30%), and inorganic materials (50%) 2. It is characterized by the presence of numerous closely packed dentinal tubules that allow continuous outward flow of dentinal fluid from the pulp, which renders the dentin surface moist 3. The quality and the strength of the bonds at the adhesive dentin interface are consequently hampered by its heterogeneous structure.

Nakabayashi et al 4 first described the current strategies for dentin bonding in 1982. They showed that bonding of resin to dentin could be achieved by applying an acid to expose the collagen matrix and dentinal tubules. This was followed by the application of hydrophilic resin to the demineralized dentin and polymerizing it in situ to form a hybrid layer. Over several years, the early multistep adhesive systems have been simplified to reduce the number of clinical steps and to overcome sensitivity due to the technique. Simplification of the bonding procedures is especially desirable in pediatric dentistry, in order to provide composite resin restorations for small or uncooperative children.

Current dentin adhesives are classified as etch-and-rinse and self-etch types, depending on the acid etching process 5,6. The two main differences between the simplified adhesives and their conventional counterparts are the incorporation of larger quantities of hydrophilic and ionic resin monomers in the adhesive formula, so as to facilitate bonding to an intrinsically wet dentin substrate and eliminate the final bonding step. The purpose of this paper is to provide an update on the current develop-
Dentin adhesives in pediatric dentistry

Update on dentin adhesives

Dentin adhesives are currently classified into two major categories: etch-and-rinse and self-etch adhesives based on the mechanisms by which they interact with the smear layer (Table 1). The etch-and-rinse types remove the smear layer before application of the resin, while the self-etch adhesives incorporate the smear layer into a hybrid coating.

**Etch-and-rinse adhesives**

Etch-and-rinse adhesive relies on the complete removal of the smear layer, which is achieved through chemical etching of the dentin surface. This process involves the application of an acidic etchant to the dentin surface, which removes the smear layer and creates micro-roughness to enhance bonding to the tooth structure. After etching, the etch-and-rinse adhesives are rinsed with water to remove excess etchant and debris, followed by application of the resin. The etch-and-rinse adhesives are further classified into three-step and two-step systems based on the number of steps involved in the bonding process.

**Table** Common dental adhesives

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<tr>
<th>Adhesive</th>
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<tr>
<td><strong>Three-step etch-and-rinse</strong></td>
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<tr>
<td>Adper Scotchbond Multi-Purpose</td>
<td>3M ESPE, ST Paul (MN), USA</td>
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<tr>
<td>All-Bond 2</td>
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<td>Optibond FL</td>
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<td>Ivoclar Vivadent, Schaan, Liechtenstein</td>
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<td><strong>Two-step etch-and-rinse</strong></td>
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<td>Gluma Comfort Bond</td>
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<td>Single Bond</td>
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<td>One Coat Bond</td>
<td>Coltene-Whaledent, Alstätten, Switzerland</td>
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<td>One-Step</td>
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<td>One-Step Plus</td>
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<td>Prime &amp; Bond NT</td>
<td>Dentsply De Trey, Konstanz, Germany</td>
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<td><strong>Two-step self-etch</strong></td>
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<td>Clearfil Protect Bond</td>
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<td>AQ Bond</td>
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<td>IBond</td>
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<td>Xeno III</td>
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The use of etch-and-rinse adhesives in pediatric dentistry is limited due to concerns regarding the potential for increased caries risk and the need for additional time and steps in the bonding process. Self-etch adhesives, on the other hand, simplify the bonding process by eliminating the need for etching, thereby reducing the risk of caries and improving patient compliance. The clinical application of such adhesives in pediatric dentistry includes bonding to the dentin in primary teeth, where the hard tissue is softer and more susceptible to demineralization compared to permanent teeth.

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The mechanisms by which they interact with the smear layer (Table 1). The etch-and-rinse types remove the smear layer before application of the resin, while the self-etch adhesives incorporate the smear layer into a hybrid coating.

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**Two-step etch-and-rinse**

Two-step etch-and-rinse adhesives incorporate the smear layer into a hybrid coating, which can improve bonding strength and durability. Examples include Adper Scotchbond Multi-Purpose, All-Bond 2, Optibond FL, and Syntac. These adhesives are typically used in secondary dentin and are less sensitive to the dentin smear layer.

**Two-step self-etch**

Two-step self-etch adhesives utilize the smear layer as part of the adhesive system, which can simplify the bonding process and reduce the risk of caries. Examples include Clearfil Liner Bond 2, Gluma Comfort Bond, One Coat Bond, and One-Step. These adhesives are typically used in primary teeth and are more suitable for children due to their simplicity and reduced risk.

**One-step self-etch**

One-step self-etch adhesives are designed to incorporate the smear layer into the adhesive system, providing a simplified bonding process. Examples include Adper Prompt L-Pop, AQ Bond, Clearfil S Bond, and One-up Bond F. These adhesives are suitable for primary teeth and can be used in children without the need for additional steps.

**One-step etch-and-rinse**

One-step etch-and-rinse adhesives combine the benefits of etch-and-rinse and self-etch systems, providing a versatile approach to bonding. Examples include Excite, Gluma Comfort Bond, Single Bond, and Optibond Solo Plus. These adhesives are suitable for both primary and secondary dentin and offer a balanced approach to bonding.

**Conclusion**

The choice of dentin adhesive depends on various factors, including the specific needs of the patient, the type of tooth, and the desired outcome. Pediatric dentists should carefully consider these factors to select the most appropriate adhesive for their patients. The use of etch-and-rinse adhesives in primary teeth may be limited due to concerns regarding caries risk and the complexity of the bonding process. Self-etch adhesives, on the other hand, offer a simpler and more effective solution for bonding to dentin in primary teeth, providing a safer and more practical option for children.
of the smear layer using 30-40% phosphoric acid, which demineralizes the dentin to leave a microporous scaffold of collagen fibrils. After the acid is rinsed off, a hydrophilic primer is applied to the surface to infiltrate the collagen matrix and tubules.

Water-chasing solvents, such as ethanol or acetone, are commonly utilized to aid in the displacement of water from the dentinal surface and the moist collagen network, and facilitate the penetration of the resin monomers into the demineralized collagen network. 2-Hydroxyethyl methacrylate (HEMA) is frequently added to the primer solutions because it forms hydrogen bonds with water. It can also prevent excessive drying of the dentin surface due to premature evaporation of water from the demineralized collagen network. It promotes re-expansion of the collagen network and facilitates subsequent resin infiltration. Thereby, it improves the final bond strength of the adhesive. A wet-bonding technique is required with etch-and-rinse adhesives, so as to prevent collapse of the subsequently unsupported collagen fibrils as well as to enhance penetration of the primer.

Bonding agents, which primarily consist of hydrophobic resin monomers such as bisphenol A diglycidyl ether dimethacrylate (bis-GMA) and urethane dimethacrylate (UDMA), may also contain some hydrophilic monomers such as triethylene glycol dimethacrylate (TEGDMA) as a diluent and HEMA as a wetting agent. The adhesive resin is then applied and co-polymerized with a primer to form an intermingled layer and the collagen known as the hybrid layer. The bonds produced by the 3-step etch-and-rinse adhesives are relatively strong, durable, and impermeable.

The simplified 2-step etch-and-rinse process combines the primer and adhesive resin into one single application, which contains a mixture of hydrophilic and hydrophobic resin monomers dissolved in volatile organic solvents (such as acetone, ethanol or water). This mixture of different components causes the simplified adhesives to behave more like a hydrophilic primer than a hydrophobic sealing film. It is recommended that these single-bottle adhesives be applied in two coats: the first layer serving as the primer and the second as the adhesive.

The problems associated with the use of etch-and-rinse adhesives are mainly related to the narrow window of opportunity for achieving the wet-bonding technique and the difficulties in attaining complete penetration of the adhesive monomers into the acid-etched dentin. It is now well-known that excessive air-drying of acid-etched dentin following rinsing results in the collapse of the unsupported collagen matrix; thereby, compromising the bonding of resins to dentin. This led to the development of the wet-bonding technique.

Incomplete penetration of resin into the acid-etched dentin can lead to a porous zone in the bottom of the hybrid layer, which then exhibits nanoleakage. The presence of unprotected collagen fibrils at the bottom of the hybrid layer may constitute preferential pathways for degradation by oral and endogenous proteolytic enzymes that are slowly released after bonding from the etched dentin. This reduces the longevity of the bond. The incomplete sealing of dentinal tubules can cause rapid transudation of the dentinal fluid through the respective patent tubules, which results in postoperative sensitivity.

Self-etch adhesives

Self-etch adhesives were developed to overcome the problems associated with the use of etch-and-rinse adhesives. The original self-etch systems included two steps: application of an acidic self-etching primer, followed by a separate bonding step. The self-etch adhesive system relies on the use of non-rinse acidic methacrylate monomers that simultaneously etch and prime dentin, so that the disrupted smear layer is incorporated into the hybrid layer. Water is an essential component in these adhesives, which generates hydrogen ions for effective demineralization of the smear layer and the underlying dentin. Self-etch adhesives typically contain 30-40% water.

Contemporary self-etching systems may be classified as mild (pH>2), moderate (pH 1-2) or aggressive (pH<1), depending upon their ability to penetrate dentin smear layers and their depth of demineralization. Aggressive self-etch adhesives have a bonding mechanism that is similar to that of etch-and-rinse adhesives, which completely dissolve the smear layer and form a thick hybrid coating of approximately 5 μm. Mild self-etch adhesives incorporate the smear layer and smear-plugs into the hybridized complex to form a thin hybrid layer less than 2 μm thick. Despite the thin hybrid layer, high initial bond strengths producing sound dentin have been reported. While all self-etch adhesives bond reasonably well to ground enamel, there is a general consensus that the milder versions do not successfully etch unground amorphous enamel. Consequently, no resin tags are formed and there is minimal subsurface demineralization for micromechanical retention. Clinically, this may result in the stained enamel margins.
that are occasionally associated with mild self-etch adhesives. An in vitro study reported that additional etching with 40% phosphoric acid could be used to improve the bonding of mild self-etch adhesives to enamel.

Recently, 1-step self-etch adhesives have been developed that combine the conditioner, primer, adhesive resin, and water into a single application. They were initially packaged as two bottles to separate the potentially unstable hydrolytic acidic resin monomers from the water necessary for ionization of these monomers. The latest approach has been to provide the two solutions in a single bottle. These adhesives are extremely hydrophilic, because they contain large quantities of both ionic and hydrophilic monomers. Similar to the 2-step etch-and-rinse adhesives, the 1-step self-etch adhesives are directly coupled to resin composites without an additional coat of a more hydrophobic, solvent-free bonding resin.

Self-etch systems are in general less technique sensitive than etch-and-rinse systems that utilize separate etching and rinsing steps. These systems are less likely to create discrepancies between depth of demineralization and resin infiltration, because the smear layer-retained dentin is etched and bonded simultaneously. The technique associated with bonding to a dehydrated collagen matrix is also eliminated, as water is an integral part of the adhesives system. Problems of postoperative sensitivity are reduced, because removal of the smear layer and smear plugs is not required. It has also been reported that some of the functional monomers in self-etch adhesives can interact chemically with hydroxyapatite, and thereby improve the durability of the resin dentin bond.

Similar to etch-and-rinse adhesives, the simplified self-etch adhesives are more technique sensitive than their 2-step counterparts. The problems with 1-step self-etch adhesives involve difficulties in obtaining complete evaporation of all their water and solvent prior to polymerization and the entrapment of bound water within the acidic and hydrophilic monomers. Residual water and solvent may prevent optimal polymerization of the adhesive monomers.

**Bonding to primary tooth dentin**

**Composition and morphology of primary dentin**

Chemically, primary dentin is less mineralized than permanent dentin, the concentration of calcium and phosphorous in both the peritubular and intertubular dentin are lower in primary than permanent teeth. In terms of hardness and elastic moduli, primary dentin is inferior to permanent dentin and diminishes as a function of distance from the pulp. Despite the difference in chemical composition between primary and permanent teeth, manufacturers do not provide specific instructions for the use of dentin adhesives in the primary dentition; the same etching protocol is recommended for both.

Apart from the difference in chemical composition, the density and diameter of the dentinal tubules are lower in primary teeth than in correspondingly located permanent teeth. In permanent teeth, these two respective characteristics appear decreased: from 45 000 tubules/mm² and 2.5 μm near the pulp to 20 000 tubules/mm² and 0.9 μm near the enamel. The density and diameter of tubules vary from 26 391 tubules/mm² and 1.29 μm in deep dentin to 17 433 tubes/mm² and 0.96 μm near the surface. Since the primary teeth have fewer dentinal tubules, the acidic conditioners may not be diluted as rapidly as in permanent teeth.

Although the peritubular dentin in primary teeth is 2 to 5 times thicker than that in permanent teeth, it is more mineralized than in the intertubular region. Hence it etches more rapidly during the application of conditioner and leaves the etched intertubular dentin matrix with enlarged dentinal tubules. Microcanals or giant dentin tubules (5-50 μm), which extend from the incisal edge of amelodental junction to the pulp cavity, have been observed in primary tooth dentin. Scanning electron microscopic (SEM) examinations of these giant tubules in human primary dentin revealed type III and I collagen fibers, with no odontoblast processes or other cells in the large tubules. These giant tubules probably formed as a result of odontoblast crowding and necrosis or a disturbance during dentinogenesis leading to the subsequent imperfection. The chemical and structural differences between primary and permanent dentin may significantly reduce the intertubular dentin available for bonding by dentin adhesives, thus contributing to reduced bond strength for primary dentin.

Using 10% maleic acid and 10% phosphoric acid and two different bonding systems (Scotchbond Multi-Purpose [3M ESPE, St Paul (MN), USA]; All-Bond 2 [Bisco Inc., Schaumburg (IL), USA]), Nör et al. reported that the hybrid layer formed in primary dentin was nearly 25-30% thicker than that of permanent dentin using the...
same acid conditioning time. They concluded that the primary teeth are more reactive to acidic conditioners. This finding of a thicker hybrid layer in primary dentin was corroborated by in vitro studies 39,40 and in vivo study 41. It has been suggested that the buffering capacity of primary dentin may also be reduced, as it is less mineralized than in permanent dentin 42. Although there is no correlation between hybrid layer thickness and bond strength, the increased thickness of the hybrid layer in primary teeth and the subsequent lack of complete penetration of adhesive resin into the demineralized dentin can lead to a porous zone or nanoleakage at the base of the hybrid layer that contains denuded collagen fibrils 13,14. Similarly, Agostini et al 43 evaluated the bond strength of three self-etching primers to human primary dentin and showed that the use of aggressive self-etch adhesives, such as Etch and Prime 3.0 (Degussa AG, Hanau, Germany) [pH=0.6] and Prompt L-Pop (3M ESPE, St Paul [MN], USA) [pH=0.4] result in excessive demineralization of dentin and complete bond failures 43. Only the mild self-etch adhesive, Clearfil SE Bond (Kuraray Medical Inc., Tokyo, Japan) [pH=2.0] achieved adequate bond strengths to the dentin of primary teeth.

The unsupported collagen fibers at the base of the hybrid layer have been described as the weakest link within the bonded interface 44. Degradation of these unprotected collagen fibrils by oral and proteolytic enzymes results in a reduction of bond strength over time. Consequently, it has been suggested that in order to decrease the possibility of incomplete penetration of resin and the occurrence of a porous zone at the bottom of the hybrid layer, the period of exposure for conditioning the dentin of primary teeth should be approximately 50% less than that recommended for permanent teeth 45. Recently, Sardella et al 42 examined the effect of reducing the etching time on the bond strength of a conventional (Single Bond; 3M ESPE, St Paul [MN], USA) and a self-etching primer (Clearfil SE Bond) adhesive to primary tooth dentin. Shortening the period of acid etching to 7 seconds improved the strength for the Single Bond, while reducing the etching period to 10 seconds resulted in no statistically significant difference for the Clearfil SE Bond.

**Short-term bond strength**

Shear and microtensile bond strength tests are commonly employed for bond strength evaluation. Due to the variation in dentin substrates tested and the bond strength testing methodologies, the resultant data should be interpreted with caution. Such data should be used mainly for comparison of the relative effectiveness of different dentin adhesives and predicting their clinical behavior. Numerous studies have evaluated the bond strength of conventional and simplified dentin adhesives to permanent dentin. However, only a few describe performance on primary dentin. In general, the 3-step etch-and-rinse adhesives show the greatest bond strength to primary dentin, followed by the 2-step self-etch and the 2-step etch-and-rinse adhesives. The lowest bond strengths were observed for the 1-step self-etch adhesives 46,47.

When bonded to primary dentin, Casagrande et al 48 showed no significant differences in bond strength between 3-step etch-and-rinse (Scotchbond Multi-Purpose) and 2-step self-etch adhesives (Clearfil SE Bond). In the latter study the application protocol for Scotchbond Multi-Purpose was modified following the recommendation of Nör et al 38, advocating a 10% phosphoric acid and a shorter etching time of 7 seconds. In another study, Agostini et al 43 evaluated the tensile bond strength of three self-etching primers to primary dentin. A significantly higher bond strength to dentin was observed with the 2-step self-etch (Clearfil SE bond) than with the 2-step etch-and-rinse (Prime and Bond NT; Dentsply De Trey, Konstanz, Germany). Complete bond failures occurred with 1-step self-etch adhesives (Prompt L-Pop and Etch and Prime 3.0). For the self-etch adhesive, the depth of dentin demineralization depends on the pH of the self-etching primer. For example, Clearfil SE Bond is a mild self-etching adhesive, resulting in less decalcification of dentin and better adaptation of the adhesives in comparison to the traditional phosphoric acid used in the Prime and Bond NT. Atash and Van den Abbeele 49 reported significantly higher shear and tensile bond strengths for the mild 2-step self-etch (Clearfil SE Bond) and 2-step etch-and-rinse adhesives (Single Bond), when compared to strong (pH<1; Adper Prompt and Etch and Prime 3.0) and medium strength (pH 1-2) self-etch adhesives (OptiBond Solo Plus Self-Etch [Kerr, Orange (CA), USA]; AdheSE [Ivoclar Vivadent, Schaan, Liechtenstein]). Similarly, the bond strength of Clearfil SE Bond (pH=2) to dentin was significantly greater than the One-up Bond F (Tokuyama Dental Corporation, Tokyo, Japan) [pH=1.8] and the Prime & Bond NT/NRC (pH=1.2) 50. This was confirmed in a SEM study, which showed that interfacial gaps were observed in most restorations bonded with an aggressive self-etch adhesive (such as Prompt-L-Pop) 51.

Comparisons of bond strengths involving primary and permanent dentin have yielded controversial results.
Some studies revealed inferior bond strength with primary dentin, while others demonstrated similar results with both types of dentin or converse results. Differences in the adhesive composition, bonding substrates and testing methodologies may all help to explain such variations in observed bond strengths.

**Bonding to caries-affected primary dentin**

The hardness of caries-affected dentin is less than that of sound dentin, though very few studies have addressed the bond strengths of caries-affected and sound primary teeth. The bond strength of a 2-step etch-and-rinse system (Single Bond) on caries-affected primary tooth dentin was significantly greater than that on sound primary tooth dentin. Conversely, Tosun et al. showed that the bond strength of the 2-step etch-and-rinse adhesive (OptiBond Solo Plus) to caries-affected dentin was significantly more than that to sound dentin, while another 2-step etch-and-rinse adhesive PQI showed no significant difference. The subsequent SEM examinations of the bonded interfaces revealed no morphological differences between sound and caries-affected dentin. For the self-etch systems, no significant difference in bond strength was found between sound and caries-affected primary dentin, when bonding with the Clearfil SE Bond. Hence, both the 2-step etch-and-rinse and 2-step self-etch adhesives can be used effectively with caries-affected primary dentin.

**Long-term bond strength**

Decline in bond strength and degradation of the bonded interface have been reported in primary molars after aging in oral fluids. This decline is the result of hydrolytic degradation of the resin and proteolysis of unprotected collagen fibrils within the decalcified dentin. Hashimoto et al. examined the fracture patterns of adhesive composite restorations placed in caries-affected primary molars, after functioning in the oral environment for 15-17 months. They revealed that the most prevalent failure pattern for the 3-step etch-and-rinse was in the incompletely infiltrated demineralized dentin region at the base of the hybrid layer; while for the 2-step self-etch, failure at the top of the hybrid layer was commonly observed. A recent in vivo study conducted in primary-school children showed that collagen degradation by host-derived matrix metalloproteinase (MMP) can occur as early as 6 months in caries-affected dentin bonded with a simplified etch-and-rinse adhesive (Single Bond). Autodegradation of collagen matrices in the bonded interface can be prevented by the application of chlorhexidine (a MMP inhibitor) to dentin, after phosphoric acid etching.

**Clinical applications in pediatric dentistry**

An ideal dentin adhesive system should fulfill requirements such as biocompatibility, resistance to forces placed on the restorations during function, polymerization contraction, thermal contraction and expansive forces. It should also exhibit initial and long-term bonding to dentin. The evolution in dentin adhesive systems has led to improvements in their reliability and increased potential for clinical applications in different fields of dentistry. Some of these major clinical applications of dentin adhesives in pediatric dentistry are considered below.

**Management of primary teeth with early childhood caries**

The extensive destruction of primary teeth with early childhood caries poses a problem to the child and to parents, as well as a challenge to the pediatric dentist. It is necessary to restore the maxillary anterior teeth as they play an important role in the social development of a child. The evolution of adhesive dentistry makes this possible by improving the retention rates of composites to carious teeth that often have almost no enamel remaining and dentin that has been damaged by caries (Figure 1). Ideally, the dentin adhesive systems should counter the problems of polymerization contraction, differences in moduli of elasticity and mismatches of the coefficients of thermal expansion that threaten the stability of resin-tooth bonds. Otherwise, these problems could lead to microleakage, secondary caries under the restoration and to sensitivity.

**Management of teeth with developmental defects**

Management of patients with developmental dental defects such as amelogenesis imperfecta, dentinogenesis imperfecta and localized enamel hypoplastic defects, is very often clinically challenging. Dentin adhesives can be used to restore lost tooth structure, using composite resin where conventional acid etching may fail. Children affected by such inherited developmental defects experience pain because of the abnormal amelodental interface; the use of dentin adhesives can help to relieve the pain and sensitivity. However, in children suffering from such developmental defects, acid etching of enamel is usually unsuccessful because of defective or absent enamel. In such cases, a strong bond can be achieved between the exposed dentin and the composite resin restoration, using...
Management of loss of tooth structure after trauma

Traumatic injuries to young permanent teeth are not uncommon. With advancement in dentin adhesives, it is now possible to achieve excellent results with reattachment of the broken tooth fragment when the fracture line involves dentin and enamel. Dentin adhesives play an important role by utilizing exposed dentin, which can increase the bond strength of the restorative material and help re-attach broken tooth fragments, in patients with uncomplicated crown fractures. Advantages of using the dentin bonding agents to reattach fractured tooth fragments include: reduced chairside time and good shade match, but the principal disadvantage is uncertainty of the repair’s longevity.

Pulp capping

The use of dentin adhesives in sealing exposed pulp after trauma to young permanent teeth has been documented. The concept behind this procedure is that dentin adhesives completely seal the exposed pulp and therefore prevent microleakage, which in turn helps healing of the pulp and possible formation of a dentin bridge. Crucially, clinical success demands control of hemorrhage before the placement of dentin adhesives over the exposed pulp. In an in vitro study by Ersin and Eronat, pulp capping of human and sheep teeth was performed using dentin adhesives (Prime & Bond 2.1) and calcium hydroxide. At 7 and 90 days post-procedure the teeth were extracted and it was concluded that Prime & Bond 2.1 enhanced pulp healing and bridge formation in sheep teeth, but in human teeth this course of action was not as successful as pulp capping with Ca(OH)₂. However, the results obtained from a single in vivo animal study cannot be directly extrapolated to human clinical conditions. Many in vitro studies have reported the metabolic
cytotoxic effects of resin components when applied to fibroblasts. The cytotoxic effect of resinous materials and their components (hydrophilic monomer HEMA present in most primers and adhesive resins) is well documented. Ratanasathien et al. demonstrated that the toxicity ranking of dentin bonding components used as pulp capping agents after 24 and 72 hour exposures was as follows: bis-GMA>UDMA>TEGDMA>HEMA. Direct pulp capping with a dentin adhesive system is not recommended.

Conclusions

Difference in the adhesive composition, bonding substrates, hybrid layer thickness and testing methodologies are thought to be responsible for the variation in bond strengths between the primary and permanent dentin. In general, 3-step etch-and-rinse adhesives consistently show the greatest bond strength to primary tooth dentin. The lowest bond strengths were observed with 1-step self-etch adhesives.

References

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