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ADHESIVE STRATEGIES FOR RESTORING PRIMARY AND YOUNG PERMANENT DENTITION– A REVIEW

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ABSTRACT

The development of dental materials that effectively bond with tooth structure has enabled a minimally invasive approach to restoring carious lesions in children. Recent research has focused on adhesive systems, which play a crucial role in these restorative procedures. This review highlights the characteristics and interactions of contemporary adhesive systems with enamel and dentinal tissues. Dental adhesives have various clinical applications and can be classified as "etch-and-rinse adhesives" and "self-etch adhesives." Etch-and-rinse adhesives demonstrate superior performance on enamel, while self-etching systems may be more suitable for bonding to dentin. In primary teeth, etch-and-rinse adhesives have shown better results. Careful consideration of multiple factors is essential when selecting the appropriate adhesive strategy to avoid potential issues such as restoration failure, secondary caries, pulpal involvement due to leakage or bacterial penetration, or cytotoxic effects caused by eluted adhesive components.

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INTRODUCTION

Dental caries is the most frequent chronic childhood disease worldwide. Despite the decrease in dental caries prevalence, it is still considered the main oral health problem for children and adolescents.(1) Dental caries contemporary management comprises identification of an individual's caries risk, active surveillance to assess disease progression and use of appropriate preventive services or restorative therapy. Nowadays, there is a real preference to manage decayed primary and permanent teeth with a minimally invasive dentistry approach owing to the advancement in understanding of the caries process and the development of adhesive restorative materials .

Currently, pediatric dentists all over the world are confronted with a plethora of research and updates in adhesive dental restorations which are constantly evolving. That is why the best material choice for each restorative situation is becoming a source of perplexity. This review will provide brief information on adhesive restorations used for modern pediatric dental practice. It will define the various categories of adhesive restorative materials described and discuss the distinctions in their clinical selection and use .

Ideal Adhesive Restorative Material

Croll and Berg noted that adhesive dental restorative materials should chemically bond to enamel and dentin, be therapeutic through fluoride release, have an antimicrobial effect, possess similar thermal expansion coefficient to tooth structure to prevent dimensional instability, have low polymerization shrinkage, should be erosion, abrasion, and wear resistant, have high cohesive strength and prevention of crack propagation as well as fulfilling esthetic demands of high polishability and being tooth colored.(2)

Enamel/Dentin Adhesives

Dental adhesives have evolved over time, progressing from no etch to total-etch and self-etch systems (Figure 1). The concept of adhesive dentistry was introduced in the 1950s with the discovery of the benefits of acid etching by Buonocore. Modern adhesive systems consist of monomers with hydrophilic and hydrophobic groups, allowing for better adhesion to dental tissues and interaction with restorative materials. Enamel and dentin adhesives, along with resin-based composites (RBCs) and compomers, have become popular choices for restoring primary and permanent teeth due to their ability to bond and preserve tooth structure. Proper application of adhesives and restorative materials is crucial for long-term success, improving retention, reducing microleakage, and minimizing sensitivity.

Currently, dental adhesive systems can be classified as "total-etch" or "self-etch" techniques. The total-etch technique involves three steps: etching the enamel with an etchant, applying a primer to the dentin, and then applying a bonding agent. The enamel is dried, while the dentin should remain moist. Adequate enamel etching is indicated by a frost-white appearance. A simplified adhesive system combining primer and adhesive is available. Self-etch adhesives can be two-step or one-step systems (Figure 1). Universal adhesives differ from self-etch systems due to specific monomers that enhance adhesion to dental substrates. Various studies have suggested the superior performance of etch-and-rinse adhesives in primary teeth in comparison with self-etch systems of primary teeth. A systematic review with meta-analysis of in-vitro studies by Lenzi et al 2016, evaluated the immediate or after ageing bond strength of etch-and-rinse and self-etch adhesive systems to enamel and dentin and reported that etch-and-rinse adhesives in primary teeth performed better.(3) Lenzi et al 2017, evaluated the 18-month clinical performance of a universal adhesive, applied under different adhesion strategies (either self-etch or etch and-rinse protocol), after selective carious tissue removal in primary molars. They concluded that self-etch and etch-and-rinse strategies did not influence the clinical behavior of universal adhesive used in primary molars after selective carious tissue removal; although there was a tendency for better outcome of the self-etch strategy.(4)

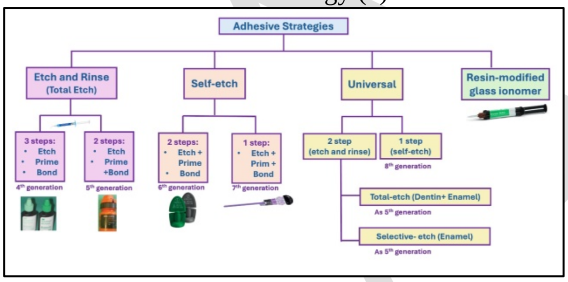

Figure (1): Modern Adhesive Strategies

The inferior performance of 1-step self-etch adhesives in dentin has been attributed to certain factors. First, these products create very thin coatings, which may be oxygen inhibited, resulting in a poorly polymerized adhesive layer. Second, they are prone to phase separation as the solvent evaporates from the solution. Finally, they behave as permeable membranes after polymerization. It has also been demonstrated that employing simplified self-etch adhesives in enamel can result in osmotic blistering and, consequently, bond failure when they are not covered by a hydrophobic resin layer.(5)

Silorane-based adhesives, which reduce polymerization shrinkage, offer a simplified bonding procedure but may be influenced by the surface morphology of prepared enamel and dentin.(6) Therefore, this combination is a potential option for restoration in pediatric dentistry.

Types of adhesive restorative dental materials

1. Resin based composites (RBCs)
2. Glass ionomers (GIs)
3. Bioactive restorative materials (BRMs)
4. Resin based composites (RBCs)

a) Dental composites

Composite resin, an esthetic dental restorative material, has become an important component of pediatric restorative dentistry. This has led to a significant decrease in the use of amalgam restorations. Composites consist of a resin matrix and fillers that are chemically bonded. The fillers are classified based on their size, which affects various properties such as polishability, esthetics, polymerization depth, and shrinkage. Larger filler particles provide strength, while smaller particles enhance polishability and esthetics. Nanocomposites are composed of a matrix material and nanoscale particles, while hybrid resins combine different particle sizes to improve strength and esthetics. Flowable resins have a lower volumetric filler percentage compared to hybrid resins. Bulk fill composites offered a new perspective of applying larger increments of RBCs while achieving adequate depth of cure and shortening application time .

The initial resin used in composites, bisphenol A-glycidyl methacrylate (bis-GMA), was developed by Bowen(7) and continues to be a critical component in most modern resin systems. Quartz or engineered glass fillers were introduced to enhance color properties and wear characteristics. However, these resins exhibited color degradation over time and unsatisfactory outcomes in posterior dental arches. Treating the filler particles with silane helped bind them within the resin matrix, minimizing discoloration and degradation. The filler particles were also ground to smaller sizes, allowing for greater incorporation into the resin matrix and improved material wear. These advancements have contributed to the development of contemporary resin- RBC restorative materials available today. Chemically cured composites typically use an amine-peroxide system as the accelerator-initiator, while light-cured composites utilize a diketone-amine system activated by intense blue light. Pigments and opaquers are added to control translucency (value) and shade (chrome)

b) Compomers

Polyacid-modified resin-based composites, known as compomers, were introduced in the dental field in the mid-1990s. They contain 72% strontium fluorosilicate glass with an average particle size of 2.5 micrometers. (8) Compomers are like RBC, but with modified resin monomers that contain acidic functional groups capable of undergoing an acid/base glass-ionomer reaction after resin polymerization. This reaction allows fluoride release, making compomers useful in pediatric dentistry due to their ability to release fluoride, aesthetic value, and easy handling.

To ensure compomer placement, primers (and possibly adhesives) containing acidic components are required to etch dentin and enamel. Several studies have compared the performance of compomers in different cavity preparations to other restorative materials. It has been reported that compomers show comparable clinical performance to composites in terms of color matching, cavo-surface discoloration, anatomical form, marginal integrity, and prevention of secondary caries. (9) In primary teeth, compomers tend to exhibit better physical properties compared to glass ionomer cements (GICs) and resin-modified glass ionomer cements (RMGICs), but no significant difference has been found in their cariostatic effects.(10) Colored compomers are widely available to make dental treatment more acceptable for children. In a study by Atabek et al. in 2011, the degree of conversion of different compomer colors was evaluated in comparison to conventional compomer with varying curing times. The study found that the degree of conversion values varied among different colors. (11)

Compomers can adhere adequately to unetched enamel and dentin, according to many manufacturers. However, laboratory studies have shown that acid etching of enamel can result in higher bond strength and better marginal adaptation of compomers. This is because compomers primarily rely on micromechanical retention, such as resin tags and the resin-dentin interdiffusion zone, for bonding to tooth structure. In cases where a glass ionomer base is used as a dentin replacement, the compomer can be applied in increments as an enamel replacement .

Clinical Uses of RBCs in Restorative Pediatric Dentistry

RBCs are recommended for small pit and fissure caries where conservative restorations in both the primary and permanent dentitions are required; occlusal surface caries extending into dentin; class II restorations in primary teeth that do not extend beyond the proximal line angles; class II restorations in permanent teeth that extend approximately one third to one half the buccolingual intercuspal width of the tooth; class V restorations in primary and permanent teeth; class III restorations in primary and permanent teeth; Class IV restorations permanent teeth; strip crowns in the primary and permanent dentitions and intracanal posts for badly decayed teeth.

Preventive resin restorations (PRR) can also be realized using flowable RBCs owing to their bonding properties and acceptable wear resistance. Pit and fissure sealants were developed to manage stagnation sites that can trap food debris and microorganisms in caries-susceptible teeth. They serve as a preventive measure by forming a micro-mechanical bond to the tooth, preventing cariogenic bacteria from accessing their nutrient source. Sealants also have potential as a secondary preventive approach by inhibiting the progression of non-cavitated carious pits and fissures. (12)

Resin infiltration is primarily used to halt the progression of non-cavitated interproximal caries lesions. This technique involves the penetration of a low viscosity resin into the porous lesion body of enamel caries. Once the resin is polymerized, it acts as a barrier to acids, theoretically preventing lesion progression. A split-mouth, randomized, controlled clinical trial conducted by Sarti et al. (13) assessed the progression of proximal carious lesions on primary molars after resin infiltration. They concluded that infiltrating proximal lesions reduced radiographic caries progression in primary molars over a two-year follow-up period.

Resin-based composites (RBCs) are not recommended for teeth that cannot be isolated to achieve moisture control, individuals requiring large multiple surface restorations in the posterior primary dentition, and high-risk patients with multiple caries and/or tooth demineralization. This includes patients with poor oral hygiene and compliance with daily oral hygiene practices, as well as those with maintenance challenges.

Clinical considerations during RBC placement

a) Risk assessment

Children at high risk of caries, based on dental history and number of carious lesions and restorations, are not good candidates for RBC restorations. Likewise, teeth that cannot be isolated or suffering from extensive restorations should be restored with materials other than RBCs.(14)

b) Restoration placement time

RBCs placement time is significantly longer than that of amalgam restorations, therefore uncooperative children might not be indicated for RBCs.(15)

c) Tooth isolation

Microleakage and restoration failure occur due to inadequate isolation which leads to contamination of the bond with oral fluids and failure of bonding with RBC restoration.

d) Cavosurface preparation margins

Beveling of cavosurface margins is essential for attaining a strong bond between tooth and RBC restoration by increasing surface area for bonding and removing aprismatic enamel layer. If the aprismatic enamel layer is left untreated, the restoration will exhibit low bond strength and subsequently microleakage and recurrent decay .

e) Polymerization shrinkage

Polymerization shrinkage is considered an inherent problem arising from the polymerization reaction of bis-GMA resin leading to microleakage and pulpal infection. Shrinkage occurs due to lack of compensation of polymerization stresses during polymer hardening and forms an interfacial gap between restorative material and tooth structure. Several attempts such as the use of delayed curing techniques, incremental placement of composite, and addition of smaller filler particles to the resin could counteract the resin shrinkage. The addition of silorane monomer decreased polymerization shrinkage nearly to one percent owing to the difference in polymerization reactions of silorane which involve ring opening reactions that are characterized by expansion on setting instead of shrinkage.(16)

f) Wear

Despite the improved wear resistance of current RBCs, wear can still occur due to attrition during occlusal contact, low degree of conversion of monomer to polymer, abrasion from tooth brushing and chemical erosion .

g) Esthetics

Resin degradation along with non-silanized fillers were the main causes of discoloration of original RBCs. Color stability of RBCs has improved tremendously over the past three decades offering esthetically pleasing tooth-colored restorations.(17)

h) Finishing and polishing

Carbide or diamond finishing burs are used after polymerization of RBCs for contouring of the restorations. This is followed by polishing with sequential abrasive discs, abrasive rubber points, and/or diamond abrasive paste. Polished restorations offer pleasing esthetics as well as comfort to the patient .

i) Allergic reaction

The NIH-NIDR Risk Assessment Consensus Conference for restorative materials stated that RBCs do not pose a risk of toxicity or hypersensitivity.(18) RBCs degradation is slow and minimal and potential exposure to degradation products is prevented by rubber dams .

2.Glass Ionomers (GIs)

Glass ionomer systems are adhesive materials that bond chemically to tooth structure, comprising of calcium or strontium aluminofluorosilicate glass powder combined with a water-soluble polymer. Upon mixing, these components undergo a setting reaction involving neutralization of acid groups by the glass base, releasing significant amounts of fluoride ions. Research by Swartz et al. ,(19) in 1984 showed fluoride release can persist for at least a year. Alongside fluoride ion release and uptake, glass ionomers exhibit coefficients of thermal expansion similar to tooth structure, replicate tooth color, and demonstrate biocompatibility .

Initially, glass ionomers had long setting times and were prone to dissolution and desiccation during hardening, with poor wear resistance and low fracture strengths once set. Dentists hesitated to adopt them due to these limitations. Two modifications were introduced: metal to enhance wear resistance but had a gray color, and a light-polymerized liquid resin to enable photocuring, resulting in resin-modified glass ionomer cements (RMGICs).(20) RMGICs possess physical properties and handling characteristics making them standard restorative materials for young patients. Some RMGICs exhibit triple hardening, combining visible light curing, chemical resin curing, and extended acid/base neutralization for additional hardening. Despite improvements, wear resistance and physical strength of RMGICs still lag behind RBCs .

Recent advancements like EQUIA Forte utilize ultrafine silica nanofillers and multi-functional monomers to create strong bulk-fill glass hybrid restorative systems with exceptional physical properties and aesthetics. These materials offer better resistance to dissolution, disintegration, and wear, maintaining polished surfaces for longer periods and enhancing optical properties and translucency compared to conventional glass ionomers. Studies, such as one by Friedl et al. (21) in 2011, support the effectiveness of Equia System for posterior fillings.

Clinical Uses of GIs in Restorative Pediatric Dentistry

Although GI have not reached the esthetic appearance of RBCs, RMGI have improved esthetics, but RBCs are still more desirable for anterior teeth. Several clinical uses for GI include: (20) cavity liner/base, dentinal adhesive, fissure sealant, sandwich technique, restorative material in Class I, II, III, and V cavity preparations, and build up after pulp therapy.

Clinical considerations during GI placement

A biomimetic restoration approach suggests layering RMGI material and RBC to garner their combined benefits by reducing microleakage as well as post-operative sensitivity and benefit from fluoride ion release from glass particles.(22)

The atraumatic restorative treatment (ART) was first introduced by Frencken et al in 1994 using traditional GIs. Hand instruments such as spoon excavators are used to remove carious tooth structure followed by hand mixing of GI and its placement in the cavity.(23) ART allowed large numbers of underprivileged children access to dental treatment. Mild conditioning of cavities before GI placement using polyacrylic acid removes surface contaminants and smear layer, which improves GIs bonding to tooth structure. In 2017, a randomized clinical trial by Olegário et al was carried out to evaluate the effectiveness of single and multiple surface restorations restored with ART versus conventional treatment with bulk fill composite restorations in primary and permanent teeth. They found similar effectiveness of ART using high viscosity GIC and conventional treatment using bulk fill composite resin when treating single or multiple surfaces in posterior primary and permanent teeth and thus, ART presents superior cost-effectiveness.(24)

3.Bioactive restorative materials (BRMs)

The ever-growing desire to have an all-encompassing restorative material with the ability to not only restore the anatomy and function of teeth, but also prevent recurrence of decay and aid in restoring the natural tooth structure has led to devising a new class of dental materials termed bioactive restorative materials. As the name suggests, these materials possess a bioactive component which is most commonly a bioactive ceramic such as nanohydroxyapatite (nHAp), amorphous calcium phosphate (ACP), tricalcium phosphate (TCP) and bioactive glass (BG) mainly used for remineralization or prevention of decay. Such materials are added as fillers in RBCs or GIs to provide an alkaline medium suitable for counteracting the acidity of the carious environment and help the formation of stable calcium phosphate crystal deposits on the tooth surface.(25)

ACTIVA™ BioACTIVE Restorative™ (Pulpdent, USA) FDA approved in 2013 is an example of a calcium phosphate releasing resin based restorative material composed of resin composite and RMGIC. It is considered a valuable restorative option in cases of high caries index and if there is a need to bond to very minimal tooth structure available as the presence of GI would enhance chemical bonding between tooth and restoration.(26) In 2018, Omidi et al. conducted a study comparing microleakage in Class II cavity restorations using various materials in primary molars. It was found that microleakage at gingival margins was lowest in RBC and ACTIVA with etching/bonding, and highest in RMGI with conditioner and RMGI groups.(27)

Other bioactive components include antibacterial agents or fluoride containing compounds. Fluoride release serves the dual function of strengthening tooth structure by the formation of fluoroapatite as well as the cariostatic activity rendering the fluoride containing restorative material a strong candidate for restoring lost tooth structure and preserving the remaining one.(28)

Studies confirm the durability of nano-filled adhesive materials like Ketac Nano, which contain nanoparticles and nanoclusters in fluoroaluminosilicate glass.(29) Fluoride ion release behavior of Ketac Nano resembles conventional GIs and RMGIs, with the primer not hindering fluoride release. However, Ketac Nano's hardness falls short of ADA restoration specifications, making it unsuitable for high-stress areas but recommended for Class I, III, V, under the composite and for primary teeth by the manufacturer. Silver has been used with GIs (Ketac™ Silver, 3M™) as a method of mechanical reinforcement as well as silver release which has a caries inhibiting effect. Nowadays, it is added in the form of silver nanoparticles to fissure sealants, GIs, and RBCs. Many RBCs include quaternary ammonium compounds (QAMs) as part of their matrix to impart antibacterial activity without compromising esthetics. They could also be copolymerized with composite resin chains enhancing their stability and retention of their antimicrobial activity.(30)

Factors affecting bond strength of adhesive restorative materials

a) Effect of reducing acid-etching time on bond strength

Reducing acid-etching time for dentin can improve bond strength. Shortening the recommended etching time by half (7 seconds instead of 15 seconds) can minimize the difference between demineralization depth and resin monomer infiltration. In a study by Cavalhero et al. in 2020 (31), primary molars showed better restoration survival rates at the 18-month follow-up when dentin was etched for 7 seconds (91.4%) compared to 15 seconds (75.7% .)

b)Effect of cavity disinfection on bond strength

Minimal intervention techniques in caries removal carry the risk of leaving residual bacteria in the cavity, leading to secondary caries. To address this, disinfectant solutions have been introduced to reduce or eliminate bacteria from cavity preparations and prevent restoration failure.

In 2009, Ersin et al.(32) conducted a study to evaluate the effect of a 2% chlorhexidine-based cavity disinfectant on the bond strength of three restorative materials (high-viscosity GIC, RMGIC, and dentin adhesive with a packable composite) to caries-affected and sound primary dentin. They found that the use of chlorhexidine-based disinfectant did not significantly affect the bonding ability of the restorative materials to caries-affected and sound dentin. This suggests that chlorhexidine-based disinfectant can be used to reduce residual caries and postoperative sensitivity.

The resin-dentin interface bond in etch-and-rinse adhesive systems can degrade over time. It is speculated that matrix metalloproteinases (MMPs) are responsible for the self-degradation of unprotected collagen fibrils in the hybrid layer, even in the absence of bacteria. Chlorhexidine can act as a coadjutant in the adhesive procedure by producing a more stable hybrid layer. Its use after acid etching and before applying the adhesive system reduces bacteria and inhibits MMPs, slowing down the degradation of adhesive interfaces. In a study by Manfro et al., different concentrations of chlorhexidine digluconate (0.5% and 2%) were assessed for their effect on bond strength to primary tooth dentin immediately and after 12 months. The study confirmed that chlorhexidine solutions at different concentrations can prevent degradation of the adhesive interface in primary teeth. However, they did not have an immediate effect on bonding.(33)

c) Effect of different ways of cavity preparation on bond strength and final restorative outcome

Cavities can be prepared using high-speed dental drills as well as Er.Cr:YSGG (erbium, chromium-doped yttrium, scandium, gallium, and garnet) Lasers. In a study by Osman et al 2020 (34), the microleakage of some GI and RBC restorative materials such as: Equia System, Fuji IX GP EXTRA and G-Coat PLUS, Fuji IX GP, Fuji II LC, Dyract Extra and Giomer adhesive system FL-Bond II and Beautifil Flow which were applied to class V cavities prepared by either Er,Cr:YSGG laser or conventional diamond bur in primary teeth, was assessed. Equia system showed the least occlusal and gingival microleakage scores regardless of the cavity preparation means.

d) Caries arresting agents and their effects on restorative materials' bond strength

The American Dental Association currently encourages the management of decay through selective caries removal.(35) Applying a caries arresting solution such as silver diamine fluoride (SDF) followed by an adhesive restorative material offers a better treatment option for carious lesions in primary teeth.

The effect of SDF application on the shear bond strength of GI cement to artificial carious lesions was tested in an in-vitro study as well as the effect of conditioner and time-lapse between SDF application and restoration placement. The study concluded that application of SDF does not significantly affect the shear bond strength GIs to tooth structure and better results are obtained when GI is placed after one week of SDF application.(36)

e) Effect of adhesive restorations over partial caries removal

A multicenter randomized clinical trial was conducted in 2020 by Periera et al to assess restoration survival and pulp vitality of primary posterior teeth that were treated with either selective or non-selective caries removal over 33 months. Adhesive restorations over active moderately deep carious lesions showed satisfactory pulp and restoration survival after 33 months regardless of the technique used for caries removal.(37)

Factors associated with failure of adhesive restorations

Various studies investigated reasons of failure of adhesive restorations in pediatric dentistry. Dapian et al assessed failure of primary teeth restorations placed in high caries-risk children and found that lack of rubber dam isolation and high caries risk were among the most prominent reasons for adhesive restoration failure. They highlighted the importance of strict caries prevention regimen to prevent secondary caries in high caries risk patients subsequently preventing restoration failure.(38) Ruiz et al also investigated factors associated with adhesive restoration failures in primary dentition such as: age, dmf-t, rubber dam placement, number of restored surfaces, restorative material used, endodontic treatment, and caries profile. They also tested the impact of repair on survival of failed restorations in high caries risk children. Two levels of assessment were applied. Level one assessment considered the restoration successful if no intervention was done until the last checkup and a failure if it was repaired or replaced or required endodontic treatment or extraction. Level two assessment considered repaired restorations as acceptable if at least one surface of the original restoration is intact, while the restoration was unacceptable if all surfaces of the original restorations had to be replaced or when the teeth had to be endodontically treated or extracted. The study concluded that longevity is inversely proportional to caries risk and that endodontic as well as multi-surface restorations are major contributors in restoration failure. Restoration repair offered a treatment option to increase survivability of restorations in a simple less invasive manner which is considered an optimum choice especially when treating children.(39)

Adhesive restorations in case of enamel disorders

Amelogenesis Imperfecta (AI(

Amelogenesis Imperfecta (AI) is an inherited disorder exhibiting defects affecting both quantity and quality of enamel. It is classified into three main types: hypoplastic, hypomaturation and hypocalcified AI and 14 subtypes showing clinical phenotypical variations and consequently affect bonding to the affected teeth. Hypoplastic AI expresses thin enamel with near normal mineral content, while in hypomaturation and hypocalcification, there is an abundance of enamel proteins and lower amounts of mineral crystals with dentinal exposure. Evidently bonding with total etch technique will be successful with hypoplastic enamel, however bonding will be poor with the other two types.

Hypoplastic enamel is lost over time due to exposure to the harsh oral environment leading to dentinal sclerosis. This sclerosis hinders the resin penetration and the effect of acid etching leading to formation of a defective hybrid layer and a weak resin-tooth bond. It was found that increasing the etching time to 30 seconds did not improve the bond strength of restoration to AI sclerotic dentin. Deproteinization with 5% sodium hypochlorite (NaOCl) for 1 minute prior to etching increased the bond strength to AI-affected enamel with no effect of AI-affected dentin.(40)

Another approach was tested by Scheidt et al, which used 35% phosphoric acid and two layers of adhesive along with roughening of enamel surface. The study concluded that shear bond strength of healthy and hypoplastic enamel were almost similar with more cohesive and mixed failures occurring in hypoplastic teeth.(41)

Molar Incisor Hypomineralisation (MIH(

MIH is a disorder of enamel affecting first permanent molars which is highly prevalent nowadays. For teeth with minimal MIH involvement, hypomineralized enamel is removed and cavity margins are placed on sound enamel then RBCs are used as a filling material. RBCs are bonded with self-etch adhesives as total-etch ones will cause further loss of enamel .

Adhesion of composite to teeth affected by MIH was evaluated by Krämer et al. who demonstrated that tensile bond strength of MIH affected enamel was significantly lower than sound one. Phosphoric acid etching produces a porous less pronounced etching pattern in MIH affected enamel as seen in micromorphological analyses.(42) Bonding to porous hypomineralized MIH affected enamel is the limiting factor in adhesion, while MIH-affected dentin may be bonded conventionally .

CONCLUSION

Enamel/dentin adhesives have promoted the use of minimally invasive dentistry and encouraged the achievement of more conservative cavity designs. There has been an ongoing progress in new dentin adhesives' development attempting to simplify the process, improve their stability over time and their bond strength performance consequently improving their durability. The new adhesives are capable of abating postoperative sensitivity, improving marginal seal, reducing microleakage and developing a strong stable chemical bond to hydroxyapatite. Despite the vast progress, there is potential for further improvement to alleviate major problems such as technique sensitivity, incomplete polymerization, and polymerization shrinkage. Therefore, these problems should be addressed through future innovation of an ideal adhesive restorative material .

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