Original Article

The Effect Of Structural Abnormalities Resulting From Different Dental Anomalies On Dental Adhesion: A Review

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Abstract

Background: A number of anomalies, resulting in defective tooth structure, can occur during the process of tooth formation. Though it is impossible to stop these defects from happening but advances in the science of dental materials have led to the development of such materials and protocols which can effectively restore such defects. Although, adhesive dental procedures, in particular, might be complicated by these intrinsic or acquired anatomical abnormalities, material scientists are finding ways to improve the bond strength with these defective structures. Objective: Our goal in conducting this literature review was to discover methods that have been shown to enhance the quality of the adhesive bond between the restorative materials and aberrant tooth structures resulting from different anomalies.

Methods: The systematic search was undergone in three electronic databases : PubMed, ScienceDirect and Google Scholar, using the following key words: teeth abnormalities, Dental enamel, Enamel defect, fluorosis, amelogenesis imperfecta, Acid etching, Bonding, ultrastructure. A manual search was performed based on the electronic search bilbiography.

Conclusion: The findings indicate that bond strength is worse with teeth having structural defects compared to normal ones. Several methods, including deproteinization with sodium hypochlorite solution, extended etching, micro abrasion, and the application of adhesion boosters, have been proposed as potential solutions to this issue. A major difficulty in dentistry practise is presented by structural anomalies, which reduces the quality of adhesive bonding to enamel and dentine. Phosphoric acid etching and self etch systems have shown improved bonding in cases of amelogenesis imperfecta. Micro abrasion and extended etching have both been shown to be beneficial to the bonding technique in the case of fluorosis. To find methods to enhance adhesion to the teeth with structural defects, further clinical studies with extended follow-up periods are needed.

1.Introduction

Adhesives have been used in the dentistry for more than 60 years now(1). Adequate adhesive procedures have been shown to reduce postoperative sensitivity, decrease marginal leakage and its consequences namely, staining and recurrent caries (2, 3). While techniques for bonding to enamel have been developed that result in good micromechanical retention between conditioned enamel and adhesive monomers (4, 5), bonding to dentin still remains a significant clinical problem (6). Dentin is a complex human tissue that behave differently depending on it is location in a tooth and how it has responded to or been attacked by the oral environment (7, 8). Dentin's adhesion process is more complicated than enamel's, making it more difficult to treat clinically and less amenable to standardisation (9).

Patients' aesthetic expectations have grown in the modern age of conservative and minimally invasive dentistry. As a result, bonding has become a crucial part of modern dentistry practise and a primary area of research and development. Principles of adhesive bonding that are safe for healthy teeth are already common knowledge (10). For example, when attaching to healthy enamel, we get micro tags that result in micro mechanical anchoring. Dentin's naturally moist surface and increased organic content makes the process more difficult. The acid etching process demineralizes the dentinal tubules and eliminates the primary smear layer. The exposed collagen of intertubular dentin is penetrated by the resin resulting in the hybrid layer. When dental anomalies are present, they alter the composition and structure of the enamel and/or dentin. This makes the adhesive bonding methods challenging. Restorations performed on altered structures had a 43% failure rate, according to the research. In light of this alarmingly short lifespan, the question of whether or not the damaged tooth surface can still create an adequate connection with the bonding materials (composites or ceramics) emerges (11). To determine the best methods for bonding such altered structured teeth, this study analyses the quality of adhesion on teeth in cases of amelogenesis imperfecta, fluorosis, molar incisor hypomineralisation, and dentinogenesis imperfecta abnormalities.

2.Bonding in cases of enamel & dentine malformation:

2.1. Amelogenesis Imperfecta (AI)

Amelogenesis imperfecta (AI) is a genetic condition that results in altered enamel formation.. There are four major categories, including hypoplastic, hypomature, hypomineralized, and hypoplastic or hypomature with taurodontism. Changes in enamel and dentin adhesiveness values may result from structural abnormalities within this anomaly (12, 13). When comparing healthy and damaged enamel, the healthy enamel has a better adhesiveness. Even though hypomineralized and hypomature AI are characterised by a deficient mineralization, investigations have revealed that they include the three typical etching facies seen on a healthy enamel. Therefore, 35% phosphoric acid etching remains appropriate. However, in the case of hypoplasia, the quality of the etching relies on the clinical appearance. Pitted hypoplasia does not affect bonding, while other clinical types (smooth hypoplastic, AI X-linked hypoplasia) may have an impact (14-18). When it comes to dentin adhesiveness, dentin in AI is less adhesive. This may be because AI-affected dentin has structural similarities with sclerotic dentin. The latter has lesser bond strength when compared to normal dentin (19-21). Nonetheless, the affected dentin still bonds better than enamel (12, 14). The efficiency of several adhesive systems on teeth with hypoplastic and hypomature AI was examined in 2011 by Pugach and colleagues. Studies have shown that self-etching systems have better bond strength than etch-and-rinse systems (22). This is because after enamel removal dentin surface becomes available to bond and self-etching is more effective on dentin. In contrast, no discernible change was identified between the two adhesive systems by Yaman et al. in 2014 (23). Lack of consistency in methodology between the two research (e.g., using the same adhesive system, sample size) prevents any firm conclusions from being drawn. The researchers have used different methods in their investigations to achieve optimal adhesion: Hirasihi et al. (2008) evaluated the impact of extended etching. They found that adhesion values inside healthy dentin were reversed when the acid etching period was increased from 15 seconds to 30 seconds. However, AI-damaged dentin remained unaffected by this (21). As a means of improving adhesion, the use of a sodium hypochlorite solution to "deproteinize" the enamel before acid etching has been proposed. This will remove organic components from the enamel's structure. The enamel etched surface increased from 48.8% to 94.47% when this pretreatment was applied by the Saroglu team in 2006 (16). However, neither before nor after etching have adhesiveness value investigations shown it to be effective (14, 24). Due to the contradictory results, further research following the same technique is needed before deproteinization may be widely used as a therapeutic strategy in clinical practise.

2.2.Fluorosis

Dental fluorosis is a kind of dental dysplasia brought on by long-term fluoride ingestion. Hypomineralization of the external enamel surface is a common condition that affects permanent teeth (25, 26). These lesions are treated using the therapeutic gradient approach, which involves progressing from minimally invasive procedures to more invasive ones. Moderate to severe fluorosis will need the more extensive procedures, such as the direct restoration or the

placement a veneer or ceramic crown. All of these methods require adhesive bonding whose value is affected by the presence of this anomaly. No matter how severe the fluorosis, the bond strength is lower than that of a healthy enamel (25-29). Etch-and-rinse systems have been shown to work just as well on fluorotic enamel as they do on normal enamel, and their results are far better than those of self-etching systems (27, 30, 31). There isn't enough literature on dentin adhesion in fluorosis. The sub optimal bond strength of dentin in fluorosis was validated in 2007 by Waidyasekra's group. Contrary to enamel, the greater the degree of fluorosis, the lesser the bond strength (32). The difference between adhesiveness of healthy dentin and affected dentin is not substantial when it comes to moderate fluorosis, as noted by Ermis and colleagues in 2003. When comparing bond strength of fluorotic dentin, the self-etching systems outperform the etch-and-rinse systems (33).

There are two methods used to enhance bonding to a tooth that has been damaged by fluoride:

Chemical approach: It has been shown that etching times of 60 seconds, 90 seconds, and even 120 seconds increase adherence to mild fluorotic enamel (25, 27). Extending the primer application time is impractical since it does not significantly improve the adherence of fluorotic enamel (33). Selective etching with 37% phosphoric acid when used in conjunction with self-etching methods enhances enamel bonding.

Micro-abrasion mechanical approach: Ermis and colleagues have shown that adhesion may be greatly enhanced by removing the outer 300 micrometer of hypermineralized enamel using hydrochloric acid and silicon carbide particles using rubber tips with rotary mandrel. Consistent with these are the findings of Jayasooriya and colleagues from 2002 and Silva and colleagues from 2013 (26, 31, 33).

2.3.Molar incisor hypomineralization (MIH)

The MIH is a qualitative enamel defect. It is classified into mild, moderate, and severe MIH depending on the severity and it may impact anywhere from one to all of the permanent molars and is often accompanied by hypomineralization of the incisors (28, 34-36). In contrast to the extensive literature on AI, there is currently a dearth of research on adhesion with teeth having MIH. Possible reason being that there aren't enough hypomineralized removed teeth available for testing. In 2006, William's group used self-etching adhesive systems to evaluate the adherence of both healthy and hypomineralized enamel. Affected enamel, which is porous, has been proven to have less adherence than healthy enamel. Resinous intratubular flange development is primarily responsible for the poor adhesiveness. Furthermore, there is no discernible difference between the different adhesive syestems when compared (37, 38). It has been proposed that pretreating the enamel with 5% sodium hypochlorite can increase adhesion and reduction of the yellow dicsoloration. Its usefulness, however, remains unproven. Both the treated enamel and the control enamel have the same quality surface. The use of 2% sodium fluoride for 4 minutes before to etching has been shown to have the opposite effect on adhesion, by increasing microleakage of the enamel dhesive interface (39-41). In 2003, Lygdiakis and colleagues estimated that, for initial hypomineralized permanent molars, despite the poor adhesiveness documented by the researchers, the long term sustainability remained adequate (42).

2.4.Dentinogenesis Imperfecta

Dentin is hypomineralized and fragile in people with dentinogenesis imperfecta, a hereditary disease. It's a structural defect of the dentin-pulp complex that manifests as a qualitative defect quite often with accompanying quantitative defect. Although there are a number of publications dealing with the phenotypic heterogeneity of affected dentin, there are very few that focus on its adhesive property. These teeth seem to have less effective bonding when compared with teeth in other anomalies. Gallusi et al.'s 2006 investigation using a scanning electron microscope on teeth with dentinogenesis imperfecta revealed an defective hybrid layer in the teeth. This result further validates the poor quality of the adhesion. However, dentin bonding in such cases is not a contraindication. More research is required to improve adhesion of these teeth (43, 44).

3.Conclusion

Adhesive process is impeded by structural defects. There is a dearth of information in the literature on adhesion to these substrates. Teeth in AI have less optimal bond strength than normal teeth. Phosphoric acid at 37% concentration is still the go-to for surface treatment. The benefit of its prolonged application is still up for debate. Additional research is needed to evaluate the efficacy of self-etching systems in contrast to etch-and-rinse systems and to determine the extent to which enamel deproteinization affects the bond strength. Fluorotic enamel and fluorotic dentin have a lower adhesive interface quality. Bonding to fluorotic teeth is enhanced by self-etching methods coupled with 37% phosphoric acid and micro-abrasion mechanical treatment, which increases surface roughness. The body of work devoted to MIH is scant. The adhesive bond of these teeth has not been improved by pretreatment with 5% hypochlorite sodium or application of 2% fluoride sodium gel for 4 minutes prior to etching. Teeth in dentinogenesis imperfecta have poor adhesion because of alteration in the structure of hybrid layer. However, further research is needed to hone specific approaches that would guarantee optimal adherence to these affected tooth structuresT.

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