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Caries removal techniques: An update on relevant factors

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Abstract
Introduction: Dental caries is a chronic infectious disease with a multifactorial etiology that leads to the destruction of the dental tissues.
Objective: To analyze the literature on the influence of chemical-mechanical and conventional caries removal methods, as well as self-etching and wash-and-rinse adhesive systems on adhesion forces.
Methodology: A compilation of articles published in the last 5 years was carried out using PubMed, Google Scholar and SCOPUS. Abstracts and full texts were identified that included information on factors influencing resin application: "papacarie", "rotatory", "adhesive", "self-etching", "etch and rinse".
Results: The use of papacarie makes the dentin porous and irregular having a stronger bond. The traditional method shows the presence of smear smear affecting the bond between the adhesive and the dentin. Self-etching adhesives, by not performing the etching and rinsing step, can affect the bonding pattern on the enamel prisms. The increase to bond strength in etch-and-rinse adhesive systems is attributed to the increased porosity created in the enamel.
Conclusions: Papacarie exhibits better bonding properties and higher surface energy compared to the conventional method. Self-etching adhesives exhibit lower bond strengths than etch-and-rinse adhesives, this is attributed to increased penetration of the adhesive into the tooth surface.

Keywords: Papacarie, adhesives, self-etching, etch and rinse, caries removal

Introduction
Caries is a multifactorial disease that causes the destruction of calcified tissues [1]. Minimally invasive dentistry consists only of the removal of infected carious tissue and replacement with an adhesive restoration, so it is important to know the impact of the form of removal and the adhesives used to restore the tooth [2].
The conventional and traditional method of caries removal is the use of drills and burs [3], which is effective and fast [4]. Some of the disadvantages of this technique are the risk of over-extraction, vibration, noise, pain, discomfort and the need for local anesthesia [5]. For this reason, minimally invasive dentistry has emerged, with the use of less aggressive techniques such as the use of papacarie [6] which only removes infected tissues and helps to preserve healthy dental structures, avoids irritation of the pulp and avoids discomfort for the patient [7].
Adhesives are mechanisms that allow two parts to remain in contact, allowing tooth structures and a restorative material to restore ideal functions to the tooth [8]. Adhesives are currently classified by their generation or by the way they interact with the smear layer [9]. Adhesive systems that remove the smear layer and its smear plugs are known as etch-and-rinse adhesives [10]. Adhesives that do not use a smear step are known as etch-and-rinse adhesives [11]. Adhesives that do not use a smear step are known as etch-and-rinse adhesives. Adhesives that do not use a separate etch step are known as self-etching adhesives [11].
Adhesion to dentin that has been altered by caries is a challenge, because the mineral content and increased dissolution of apatite crystals cause an imbalance [12] and dentin collagen by bacterial enzymes leads to alterations in adhesive performance [13].

Bacterial residues, enzymes from the immune response together with physical and morphological variations of the dentin involve the quality of the hybrid layer and damage the bond of the restoration [14], that is why it is important to analyze if the removal of carious tissue through a chemical-mechanical method and a conventional method, as well as the influence of these with a self-etching adhesive system and a wash and rinse one, have an impact on the adhesion.

A good adhesion is an arduous task, and it is even more so when it is intended to be done on a tooth that has been affected by caries, due to the fact that caries itself produces alterations that lead to instability in the adhesion. The aim is to analyze the literature on the influence of chemical-mechanical and conventional caries removal methods, as well as self-etching and wash and rinse adhesive systems on adhesion forces.

Materials and Methods

Articles on the subject published through the PubMed, SCOPUS and Google Scholar databases were analyzed, with emphasis on the last 5 years. The quality of the articles was assessed using the PRISMA guide, i.e., identification, review, choice and inclusion. The quality of the reviews was assessed using the measurement tool for assessing systematic reviews. The search was implemented using the AND, OR, NOT operators. Within the keywords used for the search "papacarie", "rotary", "adhesive", "self-etching", "etched and rinsed". The keywords were used individually, as well as each of them related to each other.

3. Results & Discussion

Influence of Papacarie on Bond Strength

Chemical-mechanical systems are an alternative to conventional rotary systems. Papain is a proteolytic cysteine enzyme [7] which acts on necrotic tissues and secretions without reacting with healthy tissues and which contains anti-inflammatory and antibacterial properties and from which papacarie is made. In addition, it contains chloramines that have the potential to dissolve carious dentin by chlorinating partially degraded collagen [15]. It acts specifically at the site and against infected tissue and does not cause damage to healthy tissue [16]. This method of caries removal is based on the removal of softer infected dentin, which is caused due to the interaction with exposed collagen [17] and allows easy removal of the lesion [18], this gives a rough dentin surface suitable for stronger bonding [19]. The residual dentin after the use of papacarie improves the bond strength and also the dentin is free of smear layer [6] and open dentinal tubules with permeable orifices are also found [16]. Papacarie significantly reduces the formation of gaps between adhesives and also eliminates the organic phase of smear layer and enamel, helping to improve the sealing performance of self-etching adhesives on enamel as well as dentin [20]. It has also been reported that chemo mechanically treated teeth have better bonding properties compared to conventionally treated dentin surfaces, and the dentin surfaces of chemo mechanically treated teeth have more surface energy [21].

The application of papacarie for the removal of carious tissue makes the residual dentin more porous and irregular, exhibiting a stronger bond and an improved marginal seal and enamel surface characteristics, removing excess protein, allowing the creation of etching patterns type I and II, and a dissolution of the prism peripheries which improved bonding.

Influence of rotary systems on the bond strength

In the selective excavation technique, more attention should be paid to carious cavities in enamel. Although the enamel surrounding open cavities is less demineralized than that of closed lesions, it is still demineralized and this condition could compromise adhesion [22]. Traditional caries removal involves the complete removal of carious tissue, with the aim of creating preventive margins to leave the boundaries of the restoration in healthy tissue [23], mechanically preserving the restoration in the tooth, as well as ensuring the complete removal of bacteria [24] including color-changing dentin and preventing the development of the carious lesion process [15]. Drills and sharp hand instruments are used, which have the benefit of simplicity, speed and efficiency [4], but also have major disadvantages, one of which is to establish the amount of dentin to be removed, since removing carious tissue also removes healthy tissue [25]. The removal of caries with rotary instruments showed a smooth surface with a typical dentin smear and occluded dentin tubules [26]. These morphological features may decrease the dentin surface area for micromechanical retention of the adhesive resin after caries removal [16]. In an investigation where they studied the micro leakage of composite restorations after the use of papacarie compared to the conventional method, they reported that there was no significant difference in the degree of leakage between the two [27]. On the other hand, studies reported that the surfaces drilled with burs were relatively smooth and covered with a layer of smear layer so this could affect the adhesion [26].

The traditional method of caries removal shows the presence of smear layer is another major disadvantage, as it is composed of two amorphous layers, one superficial and one deep, the latter can extend up to 110 µm into the dentinal tubules and is called smear plug. This smear layer seals the adhesive interface and does not contribute to the coupling between adhesive and dentin.

Influence of the self-etching adhesive on bond strength

Histologically demineralized enamel is different from healthy enamel, which relates it to reduced bond strength due to unsatisfactory conditioning pattern and resin monomer infiltration. This justifies the lower bond strength of adhesive systems to enamel adjacent to carious dentin lesions [22]. Adhesives that do not use a separate etching step are known as self-etch adhesives [28]. They can be classified according to the clinical application mechanism into single-step self-etch adhesives, which is also referred to as all-in-one or two-step adhesives [29]. This adhesive system is generally water-based, thus simplifying dentin moisture control [30]. Instead, it integrates the smear residue into the adhesive interface while slightly decalcifying the surface hydroxyapatite in dentin and enamel [10]. Recently developed universal adhesives have a chemical bonding ability due to functional monomers to hydroxyapatite, which is important for bond stabilization over time. Among the functional monomers currently used, 10-methacryloyloxydecylphosphate dihydrogenase has shown effective and durable bonding to dentin [32].

Self-etching adhesive systems by not performing the etching and rinsing step, leave dissolved in the adhesive all the smear dentin that rested on the carved cavity, together with detritus and bacteria, and the bonding pattern on the prisms of the enamel surface may be affected.

Influence of etched and rinsed adhesive on bond strength

At the time of caries extraction more attention is paid to the dentin-pulp complex. However, enamel bonding is of utmost importance, as it is affected by the stability of the resin bonded dentin and the effectiveness of the marginal seal. It should be taken into account that at the time of using any caries removal method, a degree of demineralized enamel is left at the margins of the cavity [22]. The use of phosphoric acid as etchant and polyacrylic acid significantly increases the fatigue resistance [33]. Similarly, a recent study [34] reported that the fatigue resistance of the bond of universal adhesives was higher in the etch-and-rinse mode than in the self-etching mode. Adhesive systems in which etching is performed first followed by mandatory rinsing aid in the removal of smear layer and plugs. In etch-and-rinse adhesives, the primer and adhesive are integrated in a single bottle. In this, the wet bonding technique should be performed to ensure complete expansion of the collagen network [30]. Acid etching in enamel helps to dissolve the enamel rods, making macro- and micro porosities that are penetrable, even by ordinary hydrophobic bonding agents, by capillary attraction. After polymerization, this micromechanical interlocking of small resin tags within the acid-etched enamel surface aids in better bonding that can be achieved with the substrate [35]. Acid etching promotes demineralization of the dentin exposing the collagen fibrils. The next step involves the application of a primer containing hydrophilic monomers, such as 2-hydroxy ethyl methacrylate, dissolved in organic solvents such as acetone, ethanol or water [36]. According to recent studies evaluating Single Bond Universal performance on enamel, it was stated that bond strength was higher when used with the etching strategy [22]. In another study in which Scotch bond Universal (3M ESPE) was used, it was shown that there is a higher adhesive resistance to micro-scratch when using this product with an acid etch and wash technique [37].

The increase in bond strength in etch-and-rinse adhesive systems is attributed to the increased porosity created in the enamel, which results in greater penetration, helping to achieve high micromechanical retention.

Conclusions

Chemo-mechanically treated teeth exhibit better bonding properties compared to conventionally treated dentin surfaces, and the dentin surfaces of chemo-mechanically treated teeth have more surface energy. Self-etching adhesive systems exhibit lower bond strengths than self-etching adhesives with acid etching, this is attributed to greater penetration of the adhesive into the tooth surface.

Conflict of Interest

Not available

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