ADA CE Program ARTICLE 2

The influence of hemostatic agents on dentin and enamel surfaces and dental bonding

A systematic review

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Cavity preparation procedures often cause gingival bleeding, which may be a result of tissue trauma or gingival inflammation.[1,2] In addition, the need to control moisture and contamination is common in restorative dentistry, especially when rubber dam isolation is not feasible.[3] In these cases, hemostasis becomes of utmost importance in maintaining the ideal, contaminant-free operatory field.[4,5]

The most common procedures used to control bleeding and decrease the flow of gingival fluid involve the use of a topical hemostatic agent.[6,7] These agents are based on two categories of pharmacological action: astringents (blood coagulation factors) and vasoconstrictors (adrenergic agents).[5,8] Meanwhile, the use of these agents raises doubts about whether bonding on hemostatic-contaminated dentin and enamel results in decreased bond strength.

Abundant information is available regarding the local effects of hemostatic agents on the

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ABSTRACT

Background. Hemostatic agents have been used clinically in dentistry for many years to control bleeding. The authors reviewed scientific publications in which researchers investigated the effects of hemostatic agents on dentin and enamel surfaces and on bonding of adhesive systems and resin cements.

Types of Studies Reviewed. The authors screened PubMed and Scopus databases for studies in English published from 1980 to 2013. They read the titles and abstracts to identify literature that fulfilled the inclusion criteria. The authors included studies in which researchers evaluated the hemostatic action on the dentin and enamel surfaces or its influence on the bond strength of adhesive systems or resin cements. They used cross-referencing to identify more articles.

Results. Twenty in vitro studies met the inclusion criteria. Investigators in 12 of these studies evaluated the bond strength to contaminated dentin. Investigators in 10 of these studies reported a significant decrease in bond strength. Those in two studies evaluated the influence of a hemostatic agent on the dental enamel and reported decreases in bond strength. Researchers also reported significant increases in microleakage of self-etching adhesives on contaminated dentin. Scanning electron microscopy revealed partial removal of the smear layer or an etching effect of dentin as a result of the application of hemostatic agents on dentin.

Practical Implications. Adhesive procedures may be affected adversely when performed on dentin and enamel contaminated by hemostatic agents. Hemostatic agents may induce changes in the dentin surface morphology. The results of this review indicate that the bond strength of self-etching adhesive systems is affected more negatively than is that of etch-and-rinse systems. The authors found that a 60-second application of ethylenediaminetetraacetic acid followed by a water spray restored the bond strength of a self-etching adhesive to dentin; use of phosphoric acid for 15 seconds followed by a water spray also was an effective cleaning method. Direct comparison of selected studies was not possible, however, mainly because of methodological differences hampering definitive conclusions.

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surrounding soft tissue,[9-11] but little is known about their effect on enamel and dentin substrates on hybridization. Nevertheless, it is becoming increasingly important for clinicians to recognize changes in dental composition and microstructure that may occur after the application of hemostatic agents when they plan restorative procedures that depend on dentin and enamel bonding. The purpose of this systematic review was to assess the influence of hemostatic agents on bonding of adhesive systems and resin cements to contaminated tooth surfaces and to analyze their effect on the tooth surface morphology.

METHODS

Data sources. We based identification of studies to be considered for inclusion on a search strategy involving two electronic databases (PubMed and Scopus). We included studies published from 1980 to 2013. This period covered the time during which studies were published that had a focus on hemostatic agents and their influence on dentin and enamel substrates and on dentin and enamel bonding of adhesive systems and resin cements.

> **Energy-dispersive x-ray spectroscopy data showed more aluminum and ferric remnants in the groups with contaminated dentin after the dentin surface was treated with self-etching primers than in the groups treated with phosphoric acid as part of the etch-and-rinse systems.**

We prepared the following search strategy according to Medical Subject Headings terms related to the research question: "hemostatic" OR "vasoconstrictor agents" OR "ferric sulfate" OR "ferric chloride" OR "aluminum chloride" in association with (AND) "dental cement" OR "dental bonding" OR "resin luting agent" OR "dental enamel" OR "dentin." The search strategy was modified appropriately for each database. One investigator (K.O.B.) screened all titles revealed by this research strategy and searched the abstracts to identify articles that might be of relevance. The reference lists of all eligible studies also were hand-searched for additional relevant publications. The same investigator evaluated the complete articles to decide whether to include or exclude the selected studies.

Inclusion and exclusion criteria. We considered four main aspects when identifying reports for inclusion: substrate, type of hemostatic agent, cleaning procedures and evaluation method. We identified the articles on the basis of the following inclusion and exclusion criteria. We included studies if the investigators evaluated the hemostatic action on the dental surface or its effect on the bond strength of adhesive systems or resin cements. We accepted permanent and primary human teeth, as well as bovine teeth, for the review. We excluded studies in which researchers evaluated hemostatic effectiveness in bleeding control or effectiveness in pulpotomy and endodontic procedures. Also excluded were studies in which researchers evaluated the cytotoxicity of hemostatic agents on human gingival fibroblasts.

Data extraction. One of us (K.O.B.) extracted the following data from the included studies and entered them into electronic spreadsheets: authors, year of publication, hemostatic agent, contamination time, cleaning method, adhesive system or resin cement, bond strength test and any other tests used (Table 1[12-31]). We did not perform any statistical analysis or meta-analysis owing to both methodological differences and differences in the combinations of materials used to create the experimental groups.

RESULTS

The searches yielded 574 citations. In total, we investigated 33 full-text studies, 20 of which qualified for this review (Figure 1, page 1124). We did not locate any additional articles by means of cross-referencing.

All of the investigations were in vitro laboratory studies published in English. Investigators in all but two studies[22,29] used extracted human teeth, and those in three of the 18 studies used primary teeth.[15,18,23] We assessed 16 hemostatic agents (Table 2, page 1125). These included both self-etching and total-etching systems, but researchers in only six studies reported results of comparisons between them.[15,17,19,21,26,30] Researchers in only one study evaluated a self-adhesive resin cement.[20] In only two studies did researchers evaluate the influence of the hemostatic agent on the dental enamel.[29,31] These researchers assessed two orthodontic adhesives in their studies.

We found no standardization among studies regarding the contamination methods. Researchers in some studies applied the hemostatic agent on the dentin surface by using a microbrush,[22,25,27,28,30] some dripped a drop of the solution on the dentin,[14,21,29,31] and others soaked the dentin specimens for days in a receptacle containing the solution.[18,23] Investigators in one study placed the dentin specimens on gauze soaked in the hemostatic agent, which was sealed in a closed container,[15] and those in two studies submerged the dentin specimens in the hemostatic agent for different application times.[25,28] Investigators in other studies did not specify clearly the contamination methods used.[16,17,19,20,24,26] In

ABBREVIATION KEY. **EDS:** Energy-dispersive x-ray spectroscopy. **EDTA:** Ethylenediaminetetracetic acid. **FTIR:** Fourier transform infrared spectroscopy. **SBS:** Shear bond strength. **SEM:** Scanning electron microscopy.