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Pulp response after application of two resin modified glass ionomer cements (RMGICs) in deep cavities of prepared human teeth

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ABSTRACT

Objectives: This study evaluated the human pulp response to the application of two RMGICs in deep cavities *in vivo*. Methods: The cavity floor prepared on the buccal surface of 34 premolars was lined with VBP (VBP), Vitrebond (VB) or Dycal® (DY), and restored with composite resin. Additional teeth were used as an intact control group. After 7 or 30–60 days, the teeth were extracted and processed for histological evaluation. The following histological events were scored: inflammatory response, tissue disorganization, reactionary dentin formation and presence of bacteria. Results: At 7 days, VBP and VB elicited a mild inflammatory pulpal response in about 70% of specimens and in 1 specimen for DY. Only 1 specimen of each RMGICs exhibited moderate tissue disorganization. Bacteria and reactionary dentin formation were not found. At 30–60 days, about 20% of specimens lined with RMGICs showed a persistent mild inflammatory pulp response while no inflammatory reaction was observed for DY. Moderate tissue disorganization occurred with both materials. Bacteria were found only in 1 VBP specimen. The mean remaining dentin thickness (RDT) in specimens lined with VBP, VB or DY ranged from 342.3 to 436.1 μm, and no statistically significant differences in RDT were found among materials or periods (two-way ANOVA, $p > 0.05$). Comparison of the two RMGICs tested for the histological events at each period showed statistically similar results (Kruskal–Wallis, $p > 0.05$). Significance: The use of the new Vitrebond formulation (VBP) in deep cavities *in vivo* caused mild initial pulp damage, which decreased with time, indicating acceptable biocompatibility.

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1. Introduction

The search for dental materials that are biocompatible with the dentin–pulp complex, in addition to having adequate physical, mechanical and esthetic properties, has guided the development of several commercial products. The availability of materials with adhesion to dental hard tissues has enabled the modern approach to operative dentistry involving minimal intervention and very conservative preparations to preserve sound tooth structure.

Direct and indirect pulp capping are clinical procedures that aim to preserve pulp vitality [1]. Several materials are indicated for indirect pulp capping, including resin-modified glass ionomer cements (RMGICs) [2]. As cavity liners RMGICs provide adequate protection to the dental pulp, preventing the occurrence of postoperative sensitivity. This characteristic is due in part to their self-adhesive nature and their capacity for reduction of stress generated by composite resin polymerization shrinkage [3]. Adhesion of RMGICs to dental substrates combined with their ability to release fluoride, which may act to prevent secondary caries, makes these materials an excellent option for use in a wide array of clinical procedures [4].

In addition to hydrosoluble polyacrylic acid ion-leachable glass, which is also part of the makeup of conventional glass ionomer cements (GICs), RMGIC formulations include organic monomers (e.g. HEMA) associated with a photoinitiator system [2]. This composition gives RMGICs a dual polymerization reaction (chemical cure and photoactivation) leading to higher flexural and diametral strengths, modulus of elasticity and wear resistance than conventional GICs [5]. On the other hand, the presence of these organic monomers may produce adverse biological reactions, such as local and systemic toxicity, pulpal reactions and allergic and estrogenic effects [6]. Regarding pulpal reactions, it is known that due to its low molecular weight and high hydrophilicity, HEMA may diffuse through dentin and reach the pulp [7,8]. In addition to HEMA, other monomers have been incorporated into RMGICs, such as Bis-GMA, which has higher cytotoxic potential than HEMA and other monomers contained in different resin-based dental materials [7–9].

The potential for RMGICs to have a cytotoxic effect on fibroblast and odontoblast-like cell cultures has been extensively documented [10–12]. Their toxic effects as direct and indirect pulp capping agents have also been investigated [13,14]. However, these studies have been conducted with RMGIC materials that were available in powder/liquid form with components that were hand mixed immediately before clinical use. More recently, paste/liquid versions of RMGIC liners have been developed and introduced to the market in convenient dispensing devices with the aim of facilitating handling, offering an improved component mixing ratio, and shortening the clinical time. However, little information is available in the literature regarding their performance, and the biological effects of these new materials have not yet been investigated. Among these new paste/liquid RMGIC formulations, Vitrebond Plus Light Cure Glass Ionomer Liner/Base (VBP) is available in a proprietary 'clicker' device, which is claimed to give simpler and more consistent mixing. Although some of its characteristics such as adhesion to dentin have been investigated [4], there are no research-based data on the effects of this new ionomeric liner when used close to the pulp. The aim of this study was to evaluate the *in vivo* biocompatibility of VBP compared to the conventional powder/liquid formulation of this material (Vitrebond Light Cure Glass Ionomer Liner/Base – VB) and calcium hydroxide cement (Dycal – DY – Dentsply, Milford, DE, USA) in deep cavities prepared in sound human teeth.

2. Materials and methods

Thirty-eight caries-free human premolars in functional occlusion and scheduled to be extracted for orthodontic reasons were selected from young patients. The mean age of the patients was around 14 years. After receiving all necessary explanations about the research protocol, experimental rationale, clinical procedures and possible risks, the parents/guardians and volunteers read and signed an informed consent form previously approved by the Institutional Human Subjects Ethics Committee.

The radiographs taken for orthodontic treatment were used to evaluate the possible presence of proximal caries or potential periapical pathology. As a common diagnostic procedure for tooth extraction, periapical radiographs were taken immediately before the extraction of each tooth.

Thirty-four teeth were divided into 3 experimental groups in which the cavity floor was lined with VBP, VB or DY (Table 1). Four sound teeth with no cavity preparation were included as an intact control group. Manufacturer information and the chemical composition of the liners are described in Table 1.

In the experimental groups, asepsis of the oral cavity was performed with a 0.12% chlorhexidine rinse prior to administration of local anesthesia. After cleaning the teeth with rubber cups and pumice slurry, buccal Class V cavities were prepared using a high-speed handpiece with copious water spray cooling. In order to standardize the cavity to a preset depth, a slightly tapered diamond bur, with its cutting area previously limited to 2.5 mm by means of a resin cap was used. The bur was replaced after every fourth cavity preparation to avoid overheating. The final dimensions of the buccal cavities were 3.0 mm long, 2.5 mm deep and 1.5 mm wide, with no undercuts [13,14]. All liners were prepared and applied strictly following the manufacturers' instructions for clinical use in cavity lining procedures. Then, enamel and the lateral cavity walls were conditioned with 35% phosphoric acid for 15 s. After etching, the cavities were water rinsed thoroughly for 30 s to remove the acidic agent, and enamel was air dried and the cavity walls (dentin) were gently dried with sterile absorbent paper. Two coats of Adper Single Bond 2 adhesive system (3M ESPE) were applied to enamel and dentin, air-thinned and light-cured for 20 s (XL1000 Curing Light, 3 M ESPE). All cavities were restored to the enamel cavosurface margin with Filtek Z350 composite resin (3M ESPE) applied in increments of 1.5 mm or less. Each increment was light-cured for 40 s. A radiometer (Demetron/Kerr – Model 100P/N 10503, Danbury, CT, USA) was used to check the curing light intensity immediately prior to each clinical procedure. The light intensity was standardized at 420 mW/cm^2 during the experiment. When necessary, any excess material at the cervical margin was mechanically removed using a fine grit diamond bur at