Available online at www.sciencedirect.com

Pediatric Dental Journal

journal homepage: www.elsevier.com/locate/pdj

Original Article

Application of a tooth-surface coating material containing pre-reacted glass-ionomer fillers for caries prevention

Mayu Suzuki [1], *Aya Yamada* [**,1], *Kan Saito, Ryoko Hino, Yu Sugawara, Mariko Ono, Masahiro Naruse, Makiko Arakaki, Satoshi Fukumoto* [*]

Division of Pediatric Dentistry, Department of Oral Health and Development Sciences, Tohoku University Graduate School of Dentistry, Sendai 980-8575, Japan

ARTICLE INFO

Article history:
Received 28 April 2015
Received in revised form
11 August 2015
Accepted 13 August 2015
Available online 6 November 2015

Keywords:
Caries prevention
Ion release
Surface pre-reacted glass-ionomer
Tooth-coating material

ABSTRACT

Purpose: Several methods have been used to prevent dental caries, including fluoride application to strengthen teeth and promote remineralization and the use of sealants to fill pits and fissures in pediatric dentistry. However, none of these methods alone can be considered a perfect preventive treatment. For caries prevention, we evaluated pre-reacted glass-ionomer (PRG) Barrier Coat (Shofu Inc., Kyoto, Japan), a tooth-surface coating material developed using PRG technology that contains high levels of controlled-release fluoride.

Methods: The tooth-surface coating material was applied clinically as a new method of preventing dental caries. Its effect on plaque adhesion, along with its preventive effect on dental caries was investigated in actual cases treated in a pediatric dentistry department of a university hospital.

Results: PRG Barrier Coat was shown to have suitable adhesive strength and to be a safe material that does not fracture the adherend. Actual ion release and acid buffering were confirmed, and when clinically applied, continuous fluoride release and recharge occurred, as did the release of the other ions. This suggests that this material promoted dentin remineralization, suppressed plaque adherence, and had a preventive effect on dental caries.

Conclusion: This material promoted enamel remineralization, suppressed plaque adherence, and had a preventive effect on dental caries. These results suggest that this coating material is appropriate for young children at high risk of dental caries.

* *Corresponding author.*
** *Corresponding author.*
E-mail addresses: yamada-a@dent.tohoku.ac.jp (A. Yamada), fukumoto@dent.tohoku.ac.jp (S. Fukumoto).
[1] These authors contributed equally to this work.
http://dx.doi.org/10.1016/j.pdj.2015.08.003

1. Introduction

So far, the field of pediatric dentistry has used several methods to prevent dental caries, such as applying fluoride to strengthen teeth and to promote remineralization and using sealants to fill pits and fissures [1–3]. However, fluoride application does not stay on tooth surfaces for a long time, and sealants have only local effects on pits and fissures. For children with abnormalities in enamel formation or tooth morphology that are at a high risk of dental caries, neither of these can be considered a perfect preventive treatment. Herein, we report our investigation of the PRG Barrier Coat (Shofu Inc., Kyoto, Japan), a tooth-surface coating material developed with pre-reacted glass-ionomer (PRG) technology that, unlike previous materials, can coat the entire tooth surface and can be expected to have a strong preventive effect on dental caries. The PRG Barrier Coat is a *Giomer* dental material that contains surface PRG (S-PRG) filler, to which PRG technology had been applied. It is characterized by its bioactive functions because of the gradual release of multiple ions. The PRG technology reacts to glass-containing acid-reactive fluoride with application of a polyacrylic acid aqueous solution to create stable, glass-ionomer-like structures inside the glass particles [4]. The tooth-surface coating material contains S-PRG filler manufactured with this technology.

S-PRG filler possesses a three-layer structure with a stabilized glass-ionomer-like structure surrounding multifunctional glass fillers, with an external hard glass layer. This enables the filler to have great physical strength and to release fluoride (F) and five other ions (Na, sodium; B, borate; Al, aluminum; Si, silicate; and Sr, strontium) without deteriorating the properties of the material. By releasing these ions, this material can be expected to have an acid-buffer effect, remineralization, and have an antibacterial action by suppressing the adherence and proliferation of bacteria on the tooth surface [5–8].

Similar to glass-ionomer cements, materials containing this filler possess a high capability for sustained fluoride release. Additional increases in the fluoride concentration in the oral cavity owing to fluoride-containing dentifrice or gel would recharge fluoride ions in the oral cavity [3,9–12].

This technology has already been applied to filling materials such as composite resin [4,12–14], adhesion systems, temporary cement, and orthodontic resin, but the tooth-surface coating material used in this study had the S-PRG filler but with a filler size that was even more miniaturized.

The purpose of this study was to apply the tooth surface coating material clinically as a new method for dental caries prevention, investigate its effect on plaque adhesion, and survey its ability to prevent dental caries in actual cases in a pediatric dentistry department of a university hospital.

2. Materials and methods

2.1. *Measurement of released ion species of the tooth-surface coating material*

The tooth-surface coating material used in this study was the PRG Barrier Coat (Shofu Inc.). The tooth surface coating material consists of Base and Active (Table 1). Base and Active of the tooth-surface coating material were mixed, and the mixture was filled in a mold (15-mm diameter, 1-mm thickness), light-cured (3 min) using a light-curing unit (Solidilite; Shofu Inc.) to obtain disc specimens. Specimens prepared in the above manner were immersed in distilled water (5 mL each, 37 °C) and removed from the water at a given time point, and immersed again in fresh distilled water (5 mL). This immersion procedure was repeated up to Day 30. Each immersion liquid was subjected to analysis of elemental concentration (Na, B, Al, Si, and Sr) using inductively coupled plasma atomic emission spectroscopy (ICPS-8000; Shimadzu Co., Kyoto, Japan). Analysis was conducted after preparing calibration curves corresponding to each element (in ppm: Na 0, 5, 20, 50; B 0, 10, 50, 100; Al 0, 0.5, 5, 10; Si 0, 0.5, 1, 5; Sr 0, 5, 20, 50). Analysis of F concentration involved the use of a fluoride ion electrode (Orion 9609BN; Thermo Fisher Scientific Inc., Waltham, MA, USA) after preparing its calibration curves (0 ppm, 0.1 ppm, 1 ppm, 5 ppm, 10 ppm). For the analysis of F ions, an ionic strength adjuster (TISAB III; Thermo Fisher Scientific Inc.) was added in the proportion of 0.1 mL of ionic strength adjuster to 1 mL of test solution.

2.2. *pH change in lactic acid solution containing the cured tooth-surface coating material*

Base and Active of the PRG Barrier Coat were mixed, and the mixture was filled in a mold (15-mm diameter, 1-mm thickness), light-cured (3 min) using a light-curing unit (Solidilite) to obtain disc specimens. Specimens prepared in the above manner were immersed in 5 mL of lactic acid solution (pH 4.0) for various time periods (0.5 h, 1 h, 3 h, 5 h, 7 h, 9 h, 11 h, 24 h). After removing the specimens from the solutions, the pH value in the solutions were measured using a pH meter (Twin pH B-212; Horiba Co., Kyoto, Japan).

2.3. *Evaluation of shear bond strength of the tooth-surface coating material*

Base and Active of the PRG Barrier Coat were mixed, and the mixture was coated on a polished surface of a bovine tooth (600-grit, enamel, and dentin) that was embedded in epoxy resin, left undisturbed for 3 s, and then light-cured for 10 s. With a Teflon mold (diameter: 4 mm, height: 2 mm) mounted on the coated surface, and the mold filled with composite

Table 1 – Composition of the tooth-surface coating material.

	State	Ingredients
Base	Slurry	Glass-filler, water, methacrylic acid monomer
Active	Liquid	Phosphoric acid monomer, methacrylic acid monomer, bis-MPEPP, carboxylic acid monomer, TEGDMA, photo-initiator

Bis-MPEPP = 2,2′-bis (4-methacryloxy polyethoxyphenyl) propane; TEGDMA = triethylene glycoldimethacrylate.