Staining Potential of Neo MTA Plus, MTA Plus, and Biodentine Used for Pulpotomy Procedures

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Abstract

Introduction: Mineral trioxide aggregate (MTA) used for pulpotomy procedures in immature permanent teeth can reduce treatment to 1 session as opposed to classic calcium hydroxide therapy, which necessitates multiple appointments. The main disadvantage of MTA use is crown discoloration after treatment. The aim of this study was to characterize 3 materials that are used for pulpotomy procedures in immature permanent teeth and assess their color stability in the presence of sodium hypochlorite solution. **Methods:** Hydrated Neo MTA Plus (Avalon Biomed Inc, Bradenton, FL), MTA Plus (Avalon Biomed Inc), and Biodentine (Septodont, Saint-Maur-des-Fossés, France) were characterized after immersion in Hank's balanced salt solution for 1 day and 28 days using a combination of scanning electron microscopy, energy-dispersive spectroscopy, and X-ray diffraction analysis. The color stability of the 3 materials in contact with water or sodium hypochlorite was evaluated by photography, spectrophotometry, and X-ray diffraction analysis. **Results:** All the materials hydrated and produced calcium hydroxide as a by-product of hydration at early age. All materials interacted with synthetic tissue fluid, forming a calcium phosphate phase. MTA Plus exhibited discoloration in contact with sodium hypochlorite. **Conclusions:** All the materials tested are suitable to be used in the treatment of immature teeth because they all produced calcium hydroxide, which is necessary to induce dentin bridge formation and continued root formation. Neo MTA Plus and Biodentine are suitable alternatives to MTA, and they do not exhibit discoloration. *(J Endod 2015;41:1139–1145)*

Key Words

Biodentine, characterization, MTA Plus, Neo-MTA, pulpotomy, staining

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Mineral trioxide aggregate (MTA) has many applications in dentistry (1). One particular use is for dressings over pulpotomies and apexification procedures. Clinical trials have shown that the use of MTA for the treatment of immature permanent teeth resulted in complete root formation earlier. A good success rate and the provision of a barrier for immediate obturation were shown (2). One-visit apexification procedures are possible with MTA (3); thus, this treatment option is attractive because it minimizes the number of visits considerably compared with calcium hydroxide apexification procedures.

The use of MTA for pulpotomy procedures brings MTA close to the coronal tooth tissue. Discoloration of the marginal gingiva has been reported with MTA use (4). MTA used to fill pulp chambers of immature teeth (5), as a dressing for molar pulpotomies (6), as an apical barrier after initial calcium hydroxide therapy (7), and for apexification procedures of replanted teeth (8) has resulted in crown discoloration. This crown discoloration will potentially contraindicate the use of MTA for these procedures regardless of the indications and the benefits the material has over traditional calcium hydroxide therapy.

The cause of discoloration is still debatable; however, the interaction of bismuth oxide with collagen present in tooth tissue (9) and sodium hypochlorite, which is routinely used during root canal therapy (10), has been indicated as the main causative factor. The use of sodium hypochlorite as an antibacterial agent before the application of the pulpotomy agent has been shown to improve the success of MTA pulpotomies for observation up to 12 months (11).

Materials based on tricalcium silicate with alternative radiopacifiers are available clinically. Such formulations include Biodentine (Septodont, Saint-Maur-des-Fossés, France) and Bioaggregate (Verio Dental, Vancouver, Canada), which do not include bismuth oxide in their formulation. Another such material, which has a similar formula to MTA, is Neo MTA Plus (Avalon Biomed Inc, Bradenton, FL). This new material has been specifically marketed for use in pulpotomies because it does not stain the tooth structure. The aim of this study was 3-fold: characterization of 3 materials that are used for the treatment of immature permanent teeth, investigation of the calcium hydroxide forming potential of these materials, and assessment of the color stability of the materials in the presence of sodium hypochlorite solution.

Materials and Methods

The materials used in this study included Neo MTA Plus, MTA Plus (Avalon Biomed Inc), and Biodentine.

Material Characterization

Scanning Electron Microscopy and Energy-dispersive Spectroscopy.

Specimens 10 mm in diameter and 2-mm high were prepared for each material type. The materials were mixed following manufacturer's instructions, compacted in molds, and allowed to set for 3 hours at 100% relative humidity and 37°C; afterward, they were removed from the molds and immersed in Hank's balanced salt solution (HBSS; Sigma-Aldrich, St Louis, MO). The materials were characterized after 1 day of immersion and 28 days of immersion in HBSS.

At each time point, the materials were removed from solution, placed in a desiccator for 24 hours, and vacuum impregnated in epoxy resin (Epoxyfix; Struers GmbH, Ballerup, Denmark). The resin blocks were then polished with progressively finer diamond discs and pastes using an automatic polishing machine (Tegramin 20,

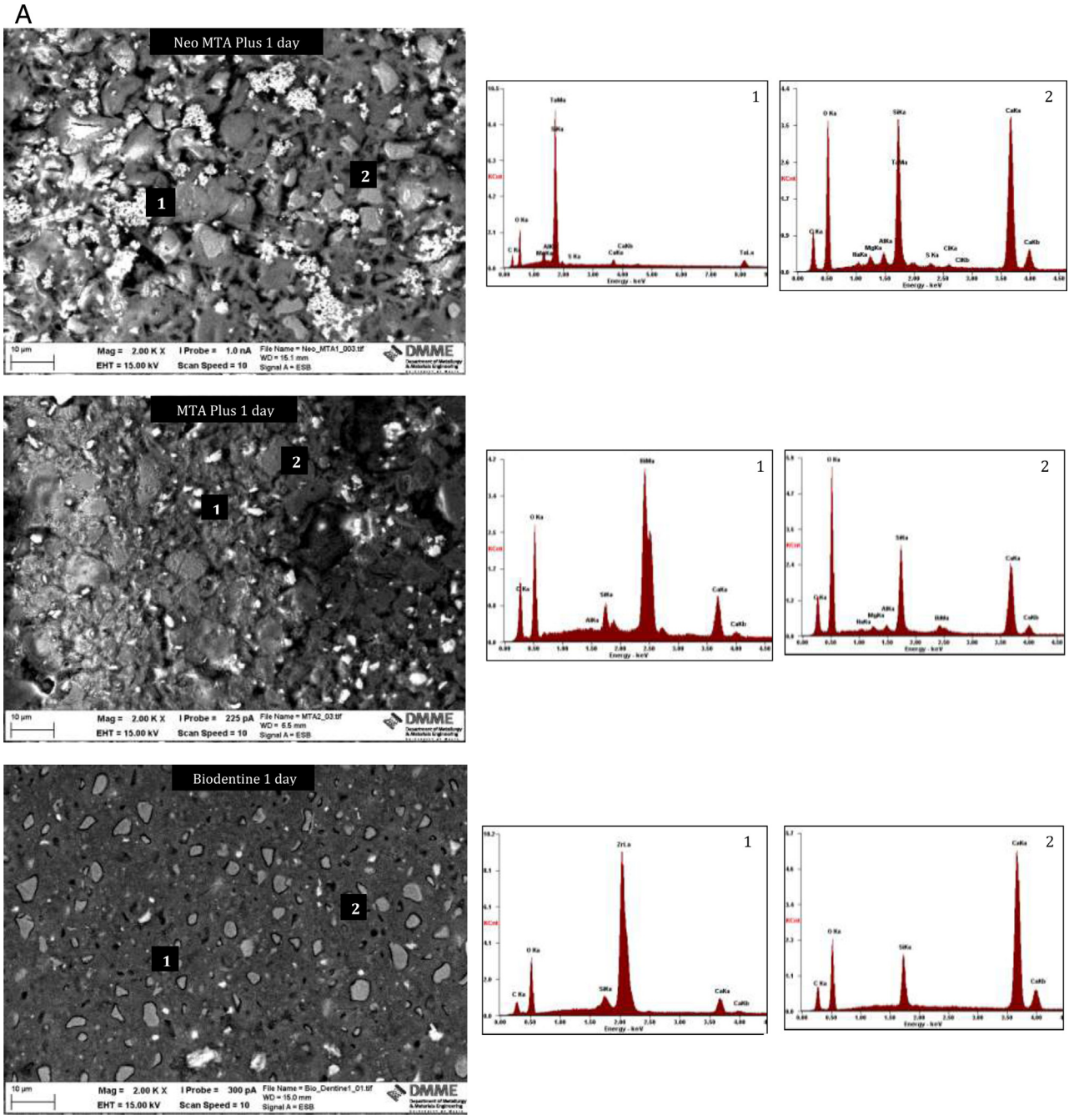

Figure 1. (*A*) Backscatter scanning electron micrographs and EDSs of test materials after immersion in HBSS for 1 day. (*Continued*.)

Struers GmbH). The specimens were mounted on aluminum stubs, carbon coated, and viewed under the scanning electron microscope (Zeiss MERLIN Field Emission SEM; Carl Zeiss NTS GmbH, Oberkochen, Germany). Scanning electron micrographs of the different material microstructural components at different magnifications in the backscatter electron mode were captured, and energy-dispersive spectroscopy (EDS) of the different phases was performed.

X-ray Diffraction Analysis. Phase analysis of set materials after 1 day and 28 days of immersion in HBSS was performed using X-ray diffraction (XRD) analysis. The set materials were removed from the soaking solution at the different time frames, dried in a vacuum desiccator, and powdered using an agate mortar and pestle. The diffractometer (Bruker D8 Advance; Bruker Corp, Billerica, MA) used Cu Kα radiation at 40 mA and 45 kV, and the detector was rotated between 15° and 45° with a step of 0.02°2θ and a step time of 0.8 seconds. The sample holder was spun at 15 rpm. Phase identification was accomplished using search match software using the International Centre for Diffraction Data (ICDD) database (International Centre for Diffraction Data, Newtown Square, PA).

Characterization of Material Surface

The material surfaces were characterized after 1 day and 28 days of immersion in HBSS by scanning electron microscopy. The materials were dried after removal from soaking solution at different time frames. The scanning electron microscope was used in the secondary electron