Color Stability of Teeth Restored with Biodentine: A 6-month *In Vitro* Study

Marta Vallés, DDS, PhD, Miguel Roig, DDS, PhD, Fernando Duran-Sindreu, DDS, PhD, Syani Martínez, DDS, MSc, and Montserrat Mercadé, DDS, PhD

Abstract

Introduction: White mineral trioxide aggregate (WMTA) has been reported to cause dental discoloration. A previous study on the color stability of 5 calcium silicate–based materials investigated the color stability of Biodentine (Septodont, Saint-Maur-des-Fossés, France) in different experimental environments; however, no data are available on the color stability of teeth restored with Biodentine. In this study, we assessed the color stability under artificial light of *ex vivo* human teeth restored coronally with WMTA or Biodentine. **Methods:** Cavities were prepared on coronal tooth specimens and restored with WMTA + composite ($n = 16$), Biodentine + composite ($n = 16$), or composite alone (control, $n = 3$). Color was assessed spectrophotometrically at 6 time points (initial, 1 week, 2 weeks, 1 month, 3 months, and 6 months), and color difference values were calculated. Statistical analysis was performed using analysis of variance and the Fisher least significant difference test for which $P < .05$ was considered statistically significant. **Results:** The WMTA group showed discoloration at 1 week, which increased over time. The Biodentine and control groups showed color stability and were not significantly different from one another. **Conclusions:** Teeth treated with WMTA exhibited discoloration, whereas those treated with Biodentine maintained color stability throughout the study. However, further *in vivo* studies are necessary to corroborate these results. *(J Endod 2015;41:1157–1160)*

Key Words

Biodentine, bismuth oxide, color stability, white mineral trioxide aggregate

From the Department of Restorative Dentistry and Endodontics, Universitat Internacional de Catalunya, Sant Cugat del Vallès, Barcelona, Spain.

Address requests for reprints to Dr Montserrat Mercadé, Universitat Internacional de Catalunya, Dentistry Faculty, C/Josep Trueta s/n, 08195 Sant Cugat del Vallès, Spain. E-mail address: mmercade@uic.es

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Mineral trioxide aggregate (MTA; Dentsply Tulsa Dental Specialties, Tulsa, OK) was developed as an apical sealing material although it has many other indications, such as pulp capping, apexification, and perforation sealing (1–3). In some of these clinical situations, MTA has a coronal position. MTA is composed mainly of calcium, silica, and bismuth oxide and is currently available in 2 forms: gray (GMTA) and white (WMTA). MTA was first manufactured in gray, but because of its potential for tooth discoloration, WMTA was developed. Although WMTA contains less iron, aluminum, and magnesium than GMTA (2), some studies have shown that tooth discoloration occurs after the application of WMTA (4–7). Furthermore, WMTA was recently shown to darken when irradiated with a curing light or fluorescent lamp in an oxygen-free environment. In contrast, WMTA maintains its color stability in an oxygen-rich environment (8).

New calcium silicate–based materials (CSMs) (3, 9) have been developed to overcome the drawbacks of MTA. Biodentine (Septodont, Saint-Maur-des-Fossés, France), a recently developed CSM, is a bioactive dentin substitute with endodontic indications similar to those of MTA (10–15). Biodentine releases calcium hydroxide in solution (16, 17), which forms hydroxyapatite on contact with tissue fluids (18–20). Biodentine contains tricalcium silicate, calcium carbonate, zirconium oxide as a radiopacifier, and a water-based liquid containing calcium chloride as a setting accelerator and water-reducing agent (21). Biodentine received good rates for material handling in a multicentric randomized clinical trial evaluating its performance (22) and has a short setting time of 12 minutes (23). In a 5-day study of the influence of light and oxygen on the color stability of 5 CSMs, those containing bismuth oxide darkened in an environment combining light and anaerobic conditions, whereas Biodentine and Portland cement showed color stability under these conditions (24). However, to our knowledge, there are no published studies on the color stability of Biodentine when used to restore human teeth.

In this *in vitro* study, we compared the color stability under artificial light of human teeth restored coronally with Biodentine or WMTA.

Materials and Methods

This study was approved by the Ethics Committee of the Universitat Internacional de Catalunya, Barcelona, Spain. The sample consisted of 35 single-rooted human teeth extracted for periodontal reasons. The teeth underwent dental prophylaxis and were polished with an abrasive paste and brush. The sample was randomly divided by the stratified random sampling into 3 groups: 2 experimental groups (n = 16) and a control group (n = 3). Each experimental group was composed of 8 maxillary and 8 mandibular teeth, and there were equal numbers of central and lateral incisors and canines between the 2 groups.

The teeth were sectioned horizontally 1 mm apical to the cementoenamel junction. The coronal pulp was chemomechanically removed using Hedström files (no. 10 for mandibular teeth and no. 20 for maxillary teeth) and 4.2% sodium hypochlorite (NaOCl) (10 mL) via retrograde access. Using a cylindrical diamond bur (Komet; Gebr. Brasseler GmbH & Co KG, Lemgo, Germany), a cavity was prepared that extended to within 2 mm of the incisal edge. The cavities were flushed with 10 mL NaOCl (4.2%) and 5 mL saline. Cavities in group 1 were filled with ProRoot WMTA (Dentsply Tulsa Dental Specialties, Lot 12001879), whereas

cavities in group 2 were filled with Biodentine (Lot 01564). The 2 materials were prepared according to the manufacturers' instructions. The cavities of the control group were not sealed. All specimens were stored in an incubator at 37°C for 48 hours in a 100% humid environment. After 48 hours, all cavities were sealed with self-etching adhesive (Xeno V; Dentsply DeTrey GmbH, Konstanz, Germany) and A3 color composite (Spectrum, Dentsply DeTrey GmbH). These adhesive materials were light cured using a Bluephase 20i light (Ivoclar Vivadent AG, Schaan, Liechtenstein) (Fig. 1).

All samples were kept at room temperature at 100% relative humidity and 10 cm below a compact fluorescent energy-saving lamp (11 W, 220–240 V, 50 Hz; Intercris Productos y Servicios SL, Anglès, Girona, Spain).

Spectrophotometric Measurements

Color values were recorded by a single operator using a reflectance spectrophotometer (SpectroShade, Handy Dental Type 713000; MHT, Arbizzano di Negar, Verona, Italy). Measurements were taken by positioning the spectrophotometer 2 mm from the samples under constant laboratory light conditions. The instrument was calibrated according to the manufacturer's recommendations before recording the measurements for each group.

Each sample was measured spectrophotometrically at 6 time points: after material placement and at 1 week, 2 weeks, 1 month, 3 months, and 6 months after restoration.

The color measurements were reported by using the CIE L*a*b* system. The value of L* is the lightness (from 0 [black] to 100 [white]), and the values of a*and b* are the red-green axis and the yellow-blue axis in the chromaticity parameter, respectively. ΔE describes the color difference between the initial time point (after material placement) and each subsequent time point measurement. ΔE was determined by using the following formula:

$$\Delta E = \left[(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2\right]^{1/2}$$

Statistical Analysis

ΔE values were statistically analyzed using analysis of variance and the Fisher least significant difference test. The significance level was set at 5%.

Results

Table 1 shows the ΔE values of the groups at the 5 time points. Significant differences were evident between the WMTA and Biodentine groups at all time points (P = .0001). At 1 week, the WMTA group showed discoloration. This discoloration increased over time; a significant difference in discoloration was evident between 1 and 2 weeks, discoloration then remained stable until 3 months, and then increased discoloration was observed at the 6-month time point. Significant differences were observed between the WMTA and control groups at each time point (P = .0001); however, there were no significant differences between the Biodentine and control groups at any of the 5 time points (P = .9347).

Figure 2 shows a spectrophotometric image of a tooth from each group at the different time points. Progressive discoloration of the tooth restored with WMTA is evident.

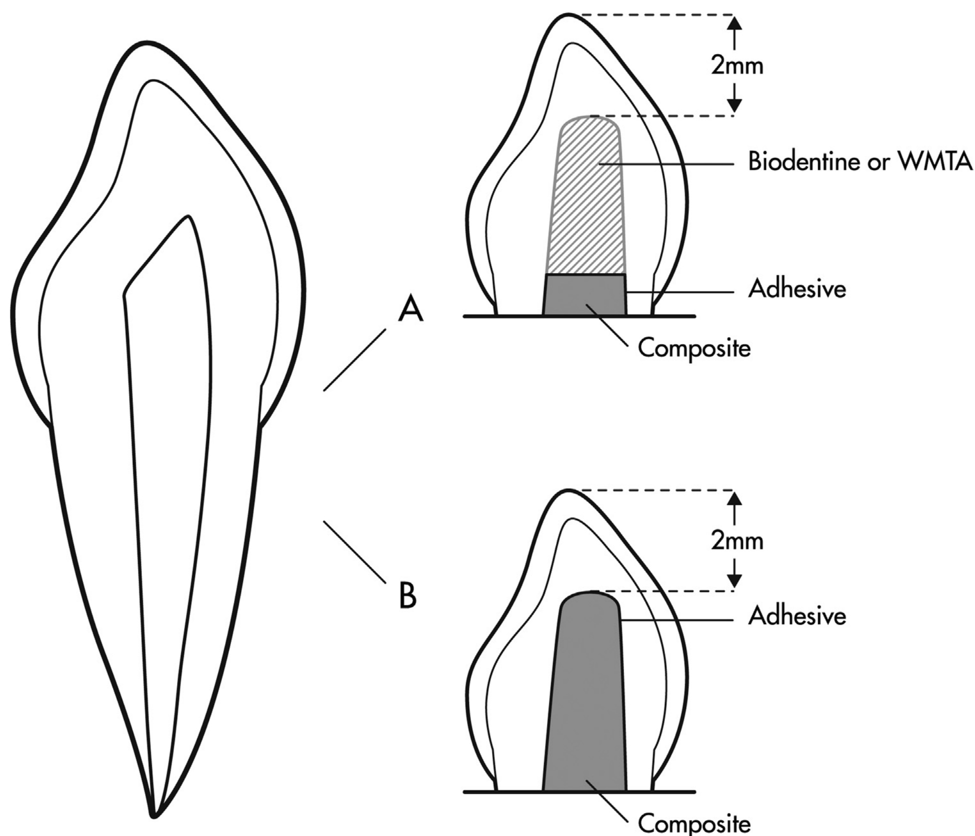

Figure 1. Schematic showing the preparation of a specimen for the experimental (A) and control (B) groups.

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