The Effect of Obturation Technique on the Push-out Bond Strength of Calcium Silicate Sealers

Christopher DeLong, DDS, Jianing He, DMD, PhD, and Karl F. Woodmansey, DDS

Abstract

Introduction: Calcium silicate–based sealers are known to have excellent sealing ability and bioactivities. They are typically recommended to be used in a single-cone (SC) technique. No studies have evaluated the effects of the thermoplastic obturation technique on the dentin interface of these sealers. The purpose of this study was to evaluate the push-out bond strengths of MTA Plus Sealer (Avalon Biomed Inc, Bradenton, FL) and EndoSequence BC Sealer (BC; Brasseler USA, Savannah, GA) when they were used in a thermoplastic technique. **Methods:** Fifty single-rooted human extracted teeth were randomly divided into 5 groups ($n = 10$), instrumented, and obturated with the SC technique or continuous wave (CW) technique: group 1, BC-SC; group 2, BC-CW; group 3, MTA Plus–SC; group 4, MTA Plus–CW; and group 5, AH Plus (Dentsply DeTrey, Konstanz, Germany)–CW. The roots were sectioned into 1.0-mm-thick slices, and bond strengths were measured using a standardized push-out test. The mode of failure was determined by visual inspection under magnification. **Results:** The MTA Plus–CW had statistically significant lower bond strengths than all other groups. The BC-SC group had statistically higher bond strengths than the MTA Plus–SC and AH Plus–CW groups. No significant differences were seen among the other groups. Modes of failure were predominately cohesive or mixed except for group 4 (ie, MTA Plus–CW) in which nearly half the specimens had no visible sealer. **Conclusions:** BC and MTA Plus sealer showed favorable bond strengths when used in an SC technique. The CW obturation technique decreased the bond strengths of these sealers. *(J Endod 2015;41:385–388)*

Key Words

Bond strength, continuous wave, EndoSequence BC Sealer, MTA Plus, push-out test

From the Department of Endodontics, Texas A&M University Baylor College of Dentistry, Dallas, Texas.

Address requests for reprints to Dr Jianing He, Department of Endodontics, Texas A&M University Baylor College of Dentistry, 3302 Gaston Avenue, Dallas, TX 75246. E-mail address: jhe@bcd.tamhsc.edu

0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2014.11.002

Tenets of endodontic obturation include effectively sealing the root canal system to prevent apical and coronal leakage (1). Because of the poor adhesiveness of gutta-percha (GP), it has been used in conjunction with root canal sealers to accomplish this goal. Traditional root canal sealers include zinc oxide eugenol, calcium hydroxide, and resin-based sealers. Although these sealers have been effective, there is still a quest for a sealer with better properties (2). ProRoot MTA (Dentsply, Tulsa, OK) is a calcium silicate cement that has proved to have excellent sealing ability, bioactivity, and osteoconductivity (3). Because of these characteristics, there is a strong interest in developing calcium silicate–based sealers for root canal obturation.

One of the more recently introduced cements is MTA Plus (Avalon Biomed Inc, Bradenton, FL). It is a powdered tricalcium and dicalcium silicate–based material that can be mixed with a liquid or a gel. Although similar in composition to ProRoot MTA, MTA Plus has a finer particle size. It can be used as a root canal sealer when mixed with the gel, which also improves the handling properties and washout resistance (4). Another hydraulic silicate cement root canal sealer is EndoSequence BC Sealer (BC; Brasseler USA, Savannah, GA [also known as iRoot SP Injectable Root Canal Sealer; Innovative BioCeramix Inc, Vancouver, BC, Canada]). Similarly, its major inorganic components include tricalcium and dicalcium silicate, calcium phosphates, colloidal silica, and calcium hydroxide. It is sold as a premixed paste containing water-free thickening vehicles (5). Because of the excellent flowability and dimensional stability, both manufacturers recommend using a single-cone (SC) obturation technique for MTA Plus and BC.

Thermoplasticized obturation techniques such as the continuous wave (CW) technique have been shown to effectively fill canal irregularities and are popular, especially among endodontists (6–8). Despite the manufacturers' recommendations, many practitioners may feel uncomfortable using the SC technique and still prefer to use a thermoplasticized technique with these new calcium silicate–based sealers. Whether the thermoplasticized technique will affect the sealing properties of these sealers has not been studied.

Therefore, the purpose of the current study was to determine whether the thermoplasticized technique has any influence on the push-out bond strengths of MTA Plus Sealer and BC. The CW technique will be compared with the manufacturers' recommended SC technique, and AH Plus sealer (Dentsply DeTrey, Konstanz, Germany) will be used as the control.

Materials and Methods

Tooth Selection and Preparation

Fifty extracted single-rooted human teeth were used for this study. Each tooth was subjected to a proximal radiograph to verify the presence of a single canal. Criteria for tooth selection included a completely formed apex and the absence of root canal filling or resorption. The external surfaces of the teeth were cleaned with gauze and sodium hypochlorite (NaOCl). Each tooth was sectioned at the cementoenamel junction with a low-speed diamond blade, and the roots were then stored in saline. The root canal was negotiated with a size 10 stainless steel endodontic file (FlexoFiles; Dentsply Maillefer, Johnson City, TN) until visualized at the apical foramen. This length was recorded, and the working length was established by subtracting 1 mm from the recorded length. All canals were instrumented to the working length using 0.06 taper nickel-titanium rotary instruments (EndoSequence, Brasseler USA) to an apical size of 0.50 mm. Canals were irrigated with 5.25% NaOCl throughout instrumentation with a side-vented needle at the

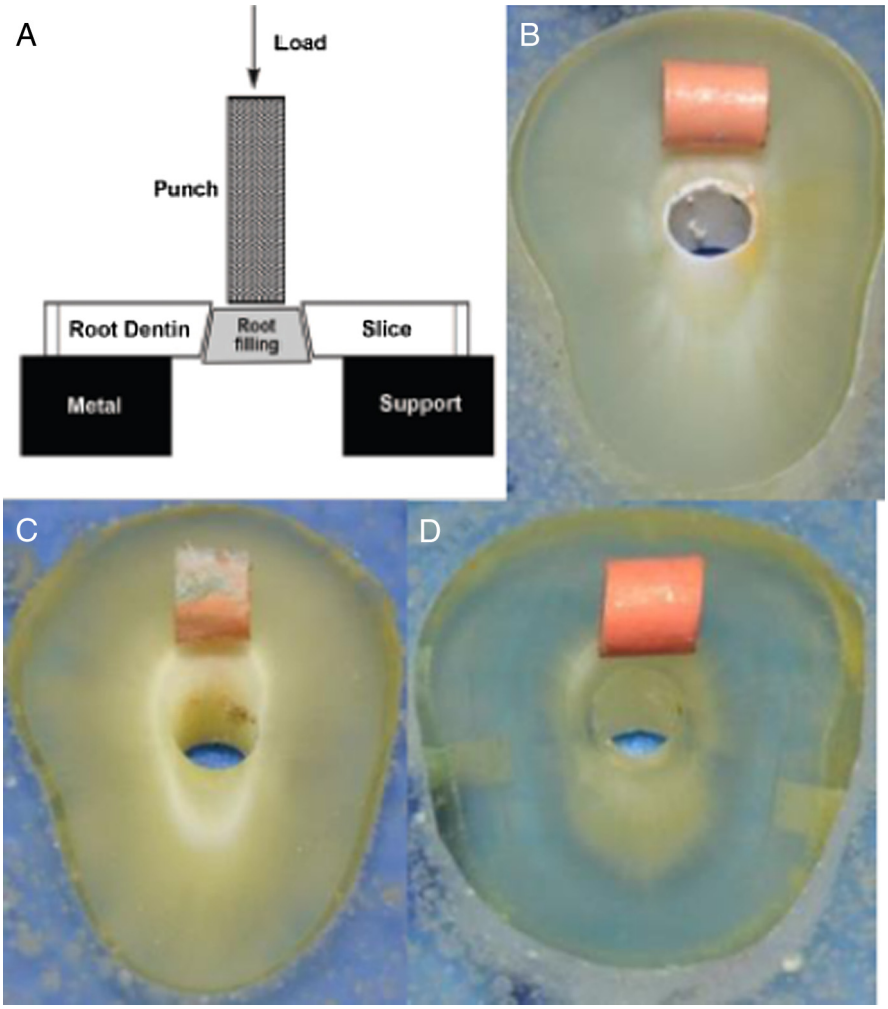

Figure 1. Push-out bone strength testing and examples of modes of failure. (*A*) A schematic representation of the setup for push-out bond strength testing adapted from Gesi et al (21). (*B*) A photograph of cohesive failure in group 1; sealer is circumferentially located on the dentinal wall, but there is none present on GP. (*C*) A photograph of mixed failure in group 3; sealer is visible on the dentinal wall and GP. (*D*) A photograph of G4 with no sealer present on the dentinal walls or GP.

working length. Final irrigation consisted of 3 mL 17% EDTA for 1 minute followed by 3 mL 5.25% NaOCl for 1 minute and then rinsed with 5 mL saline for 1 minute and dried with paper points. The specimens were stored in distilled water at 4°C. The roots were then randomly divided into 5 groups (4 experimental and 1 control, each with 10 roots) and obturated as follows:

1. *Group 1 (BC-SC):* The canals were obturated with a size 50/0.06 EndoSequence GP cone and BC using an SC according to the manufacturer's recommendation. Sealer was placed into the coronal one third of the canal with an intracanal tip (Brasseler USA). The master cone was coated with a thin layer of sealer and slowly inserted to the working length. The cone was seared off at the orifice level and lightly condensed with a plugger.
2. *Group 2 (BC-CW):* The canals were obturated with a size 50/0.06 GP cone and BC as in group 1 followed by the CW technique (System B; SybronEndo, Orange, CA) at 200°C (7). Backfilling was performed with the SuperEndo Beta Main Unit (B&L Biotech USA, Bala Cynwyd, PA) at 200°C followed by condensation with a plugger.
3. *Group 3 (MTA Plus–SC):* MTA Plus was mixed with its antiwashout gel (compounded by Prevest Denpro, Jammu, India, for Avalon Biomed Inc) to obtain a syrupy sealer consistency. The sealer was applied to canal walls with a paper point. A size 50/0.06 GP cone was coated with MTA Plus and placed to the working length. The cone was then seared off at the orifice level and lightly condensed with a plugger.
4. *Group 4 (MTA Plus–CW):* Canals were obturated with the MTA Plus sealer and a 50/0.06 GP point using the CW technique as described for group 2.
5. *Group 5 (AH Plus–CW):* The canals were obturated with AH Plus. Sealer was applied to the canal walls with a paper point, and the 50/0.06 GP cone was coated with sealer and placed to the working length. CW obturation was performed as described for groups 2 and 4.

A radiograph was made for each root to verify the absence of voids. The specimens were stored for 2 weeks at 37°C in 100% humidity to allow the sealers to set.

Push-out Test

After 2 weeks, the roots were centrally placed in a cylindrical mold and embedded vertically in Orthodontic Resin (Dentsply Caulk, Milford, DE). The specimens were stored at room temperature for 24 hours and reintroduced to 100% humidity at 37°C. Each root was horizontally sectioned into 1.0 ± 0.2 mm-thick slices using a water-cooled diamond blade on an Isomet machine (Buehler, Lake Bluff, IL). Each slice was evaluated with a digital caliper to an accuracy of 0.01 mm. An operating