Medication with Calcium Hydroxide Improved Marginal Adaptation of Mineral Trioxide Aggregate Apical Barrier

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Abstract

Introduction: The purpose of this study was to evaluate the effect of calcium hydroxide premedication on the marginal adaptation of the mineral trioxide aggregate (MTA) apical barrier. **Methods:** Forty single-rooted teeth were prepared and apically resorbed using sulfuric acid for 4 days. Teeth were allocated into two groups according to whether calcium hydroxide was placed in the canals for 1 week (medicated group) or not (nonmedicated group) before placing a 4-mm MTA apical plug in the canals. The roots were mounted on aluminum stubs, the root apex was viewed from the top under scanning electron microscopy, and the maximum distance between MTA and the surrounding dentin was measured. **Results:** The mean gap widths in the medicated and nonmedicated groups were 70.2 μm and 130.0 μm, respectively ($p < 0.05$). **Conclusions:** Calcium hydroxide treatment improves marginal adaptation of the MTA apical plug. *(J Endod 2010;36:1679–1682)*

Key Words

Apical barrier, calcium hydroxide, marginal adaptation, mineral trioxide aggregate, scanning electron microscopy

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Root canal treatment of immature teeth has many potential complications including endodontic and reparative problems. Without apical stop or constriction, it is difficult to achieve complete debridement and to limit the filling process to the tooth. The thin root walls are very susceptible to fracture during mastication. Furthermore, root-end resorption and iatrogenic overfiling in immature teeth can distract the apical constriction. Long-term calcium hydroxide apexification has historically been used to establish apical closure and avoid surgery (1). Apexification induces a calcified barrier in the root with an open apex or the continued apical development of an incomplete root in teeth with necrotic pulp (2). However, there are several disadvantages to apexification. The treatment requires multiple appointments over an extended period, which results in challenging patient-compliance issues. Additionally, the extended treatment period is associated with susceptibility to fracture, esthetic concerns, and coronal microleakage (3).

Artificial apical barriers with a variety of materials have been considered as an alternative to traditional calcium hydroxide apexification (4–7). Mineral trioxide aggregate (MTA) has become the material of choice in artificial apical barrier procedures (8). MTA can be placed in one visit, thereby eliminating the long waiting time required for calcium hydroxide apexification (9–11). Furthermore, MTA is biocompatible, nonmutagenic, and nonneurotoxic (12–15); can induce hard tissue formation (16, 17); and has good sealing properties (15, 18, 19). To disinfect the root canal, one or two treatments with calcium hydroxide are typically performed before MTA application (8). However, complete calcium hydroxide removal from the dentinal walls is reportedly impossible (20, 21). In the present study, we examine the effects of residual calcium hydroxide on the marginal adaptation of the MTA apical barrier.

Material and Methods

Preparation of Teeth

Forty extracted human maxillary single-root teeth were selected. The teeth were placed in a sterile saline solution after extraction, incubated with 5.25% sodium hypochlorite (NaOCl) for 5 hours, rinsed, and stored in saline solution. The teeth were radiographed and examined for fracture and for internal and external resorption.

Clinical crowns were sliced from the cement-enamel junction with a high-speed diamond bur (D & Z, Lemgo, Germany) under excess water to create a standardized length of 14 mm. A 25-mm #15 K-file (Dentsply Maillefer, Tulsa, OK) was placed into each canal so that its tip was seen at the foramen. Canals were instrumented using K-files up to master apical file #45 in a step-back manner with Gates-Glidden drills #1 through 4 (Dentsply Maillefer). Sodium hypochlorite (1 mL of 0.5% solution) was used between each instrument size to irrigate canals. The access opening was sealed with Coltozol (Coltene, Altstatten, Switzerland).

Apical Resorption

To produce apical resorption, the method of Ghoddusi et al (22) was used. Briefly, the roots were drowned in melted rose wax (Cavex Holland, Haarlem, The Netherlands) up to 3 mm from the apex. Waxed teeth were macerated in 20% sulfuric acid for 4 days and then rinsed with a saline solution; the wax was removed with a scalpel (Supa, Tehran, Iran). The temporary filling was also removed from the access opening.

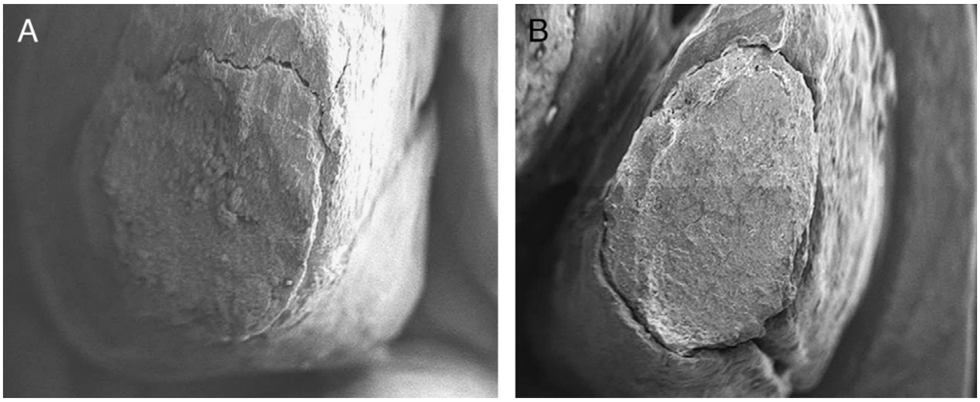

Figure 1. SEM micrographs (×57). A gap between the MTA plug and dentinal wall at the root end can be observed in the *(A)* medicated group (with prior calcium hydroxide dressing and the *(B)* nonmedicated group (without prior calcium hydroxide dressing).

Calcium Hydroxide and MTA Treatment

The teeth were randomly divided into medicated (n = 20) and nonmedicated (n = 20) groups. In the medicated group, pure calcium hydroxide mixed with distilled water (Cina Bartar, Tehran, Iran) was applied into the root canals using a Lentulo spiral (Moyco Union Brach, York, PA). Radiographs were taken to ensure complete coverage of the canal. After 1 week, the medication was removed with stainless steel hand files (Dentsply Maillefer) and 0.5% NaOCl irrigation. In the nonmedicated group, the canals were untreated before MTA use, and MTA was immediately placed in the canals after preparing the specimens.

In both experimental groups, a 4-mm apical barrier of MTA (ProRoot MTA; Dentsply, Tulsa, OK) was applied into the canals. The MTA was mixed according to manufacturer's directions, and a messing gun was used to place the material as close to the apex as possible. A hand condenser was used to condense the material to the apex. Radiographs were taken to ensure the proper placement and thickness of the MTA plug. Dankish paper points were placed in the canals. All specimens were stored at 37°C and 100% humidity for 7 days. The MTA was then tested to ensure that it had adequately set.

Marginal Adaptation

Using a high-speed diamond saw (D & Z Germany), 5 mm of the root apex was resected perpendicular to the long axis of the root to facilitate manipulation under scanning electron microscopy (SEM). Each root segment was mounted on an aluminum stub, gold sputter coated, and viewed from the top (root apex) under SEM (S360; Oxford Co, Cambridge, UK) at 100× magnification. To assess the marginal adaptation between MTA and surrounding dentin at the root apices only, measurement was performed at four points. To determine the maximum distance between the MTA and surrounding dentin, the width of largest gap in each specimen were scored and recorded (Figures 1 and 2).

Statistical Analyses

Preliminary analysis with the Kolmogorov-Smirnov test was used to confirm the normal distribution of the data. The results were analyzed by t test, with the significance level defined as α = 0.05.

Results

SEM of the root ends revealed gaps between MTA and the dentinal walls in all 40 cases. The average gap width of the medicated group (70.2 ± 34.8 μm) was markedly less than that of the nonmedicated group (130.0 ± 67.1 μm).

Discussion

In this study, sulfuric acid was used to produce open apex teeth (22). Other studies have used different methods, such as overfiling

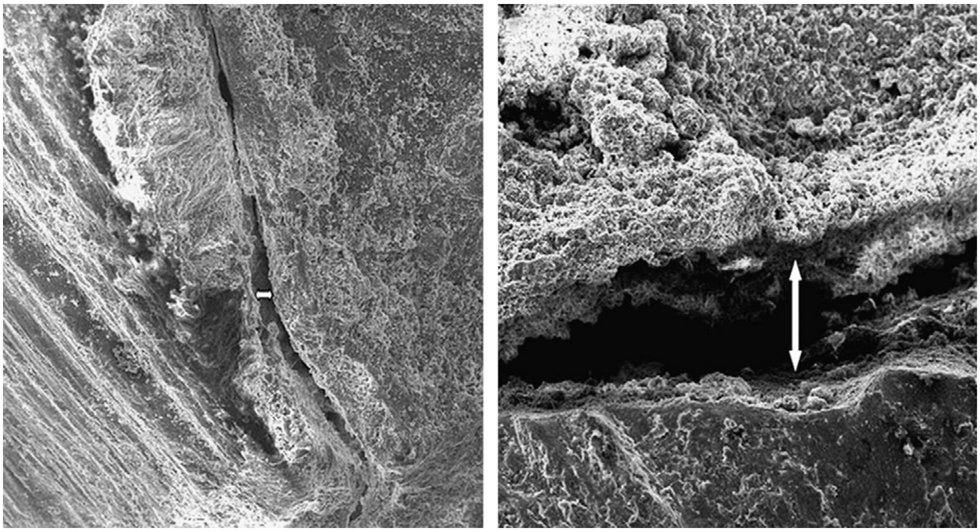

Figure 2. The gap size was measured at 300× magnification.