Fracture Resistance of Teeth with Simulated Perforating Internal Resorption Cavities Repaired with Different Calcium Silicate–based Cements and Backfilling Materials

Sevinç Aktemur Türker, PhD, Emel Uzunoğlu, PhD,† Derya Deniz Sungur, PhD,† and Vildan Tek, DDS**

Abstract

Introduction: This study assessed the fracture resistance (FR) of teeth with simulated perforating internal resorption cavities repaired with different calcium silicate–based cements (CSCs) and backfilling materials. **Methods:** Ninety-six mandibular premolar teeth were used. Twelve of the teeth were assigned as negative control group. Remaining roots were instrumented with rotary files, and standardized internal resorption cavities were prepared on the middle half of roots with burs. Twelve of the samples were not further interfered and were assigned as a positive control group. The apical 4 mm of the remaining 72 root canals was obturated with single-cone technique and divided into 6 groups according to CSCs used for repairing of cavities and backfilling materials as follows: MTA + MTA, MTA + gutta-percha/sealer, Biodentine + Biodentine, Biodentine + gutta-percha/sealer, MTA Plus + MTA Plus, and MTA Plus + gutta-percha/sealer. Specimens were embedded in acrylic resin and then subjected to fracture testing. The forces when the fracture occurred were analyzed with analysis of variance and Bonferroni tests at $P = .05$. **Results:** No significant difference was found among CSCs irrespective of backfilling materials ($P > .05$). Groups MTA + gutta-percha/sealer, Biodentine + gutta-percha/sealer, and MTA Plus + gutta-percha/sealer showed significantly lower FR compared with groups MTA + MTA, Biodentine + Biodentine, and MTA Plus + MTA Plus, respectively ($P < .05$). The highest FR was observed in group Biodentine + Biodentine, and the lowest was in group MTA Plus + gutta-percha/sealer. FR of positive control group was statistically lower than groups completely filled with CSCs ($P < .05$), whereas FR of negative control group was statistically higher than the groups combined with gutta-percha and sealer ($P < .05$). **Conclusions:** The backfilling with CSCs may be a preferable material rather than gutta-percha/sealer combination for the roots with perforated internal resorptions. *(J Endod 2018;■:1–4)*

Key Words

Calcium silicate based cement, fracture resistance, perforated internal root resorption

Significance

Reinforcement of teeth with perforated internal root resorption is essential to reduce the risk of root fracture. The backfilling with CSCs may be a preferable material rather than gutta-percha/sealer combination for strengthening the roots with internal root resorptions.

Internal inflammatory root resorption is destruction of dental hard tissues as a result of odontoclast activity (1). It is an inflammatory condition caused by the replacement of normal pulp tissue with granulomatous tissue and giant cells, which results in progressive destruction of intraradicular dentin. If the internal resorption is not detected and remains untreated, it can potentially grow larger and eventually perforate the root from inside (2). Extensive internal root resorption (IRR) with perforation may complicate the prognosis of endodontic treatment because of weakening of the remaining dental structure (3).

The repair process of IRR with perforation could be more challenging. Recalcification treatment using calcium hydroxide and/or surgical approaches has been suggested as treatments of choice (4, 5). Mineral trioxide aggregate (MTA) is most commonly used in surgical approaches to repair the resorptive cavity because of its biocompatibility, sealing ability, and potential induction of osteogenesis and cementogenesis (6). Recently, new formulations of calcium silicate cements (CSCs) have been developed. Biodentine (Septodont, Saint Maur-des-Fosses, France) is one of the recently introduced calcium silicate–based materials containing tricalcium silicate, calcium carbonate, zirconium oxide, and a water-based liquid. It is suggested to be used as dentin restorative material as well as endodontic indications similar to those of MTA. It offers advantages over MTA such as faster setting time (12 minutes) and higher push-out bond strength at 24 hours (7). MTA Plus (Avalon Biomed Inc, Bradenton, FL) is a new finer powder tricalcium silicate material, which has similar content with ProRoot MTA (Dentsply Tulsa Dental, Tulsa, OK) and MTA Angelus (Angelus, Londrina,

From the *Bülent Ecevit University, Faculty of Dentistry, Department of Endodontics, Zonguldak, Turkey; and †Hacettepe University, Faculty of Dentistry, Department of Endodontics, Ankara, Turkey.

Address requests for reprints to Dr Sevinç Aktemur Türker, Department of Endodontics, Faculty of Dentistry, Bülent Ecevit University, Kozlu 67600, Zonguldak, Turkey. E-mail address: sevincaktemur@hotmail.com

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Brazil) (8, 9). However, it is more porous, water soluble, and water sorptive compared with ProRoot MTA (9).

A hybrid technique might be used to obturate teeth with IRR; after obturation of the canal apically to the resorption defect, the defect and associated perforation can be repaired with CSCs (10, 11). However, no consensus has been reached on the material used for obturating the remaining canal space after repair of the resorption cavity. To date, there is no research on the effect of backfilling materials on fracture resistance (FR) of teeth with perforated IRR repaired with different CSCs. Therefore, this *in vitro* study was aimed to evaluate the effect of perforation repair materials such as MTA, Biodentine, and MTA Plus on the FR of teeth with simulated perforated IRR. The null hypothesis tested was that these CSCs do not affect the FR.

Materials and Methods

Mandibular mature, caries-free premolar teeth that were extracted because of periodontal reasons were selected. With the aim of specimen standardization, the mesiodistal and buccolingual diameters of the teeth were measured at the cementoenamel junction with a digital caliper. Roots presenting a difference of 20% from the mean were discarded (12). A total of 96 single-rooted teeth with a single canal and no visible caries or cracks on the root surface were used. Teeth were decoronated at the cementoenamel junction by using a high-speed diamond bur under water spray to obtain a standard root length of 12 mm. Twelve of the roots were selected as negative control group without any further intervention. The working length of the remaining 84 roots was established 1 mm short of the apical foramen with size 10 K-file, and root canals were instrumented with ProTaper Universal rotary files (Dentsply Maillefer, Ballaigues, Switzerland) up to F3. The root canals were copiously irrigated by using 3 mL 2.5% NaOCl during instrumentation.

After preparation was completed, each specimen was then placed in Eppendorf tubes filled with additional polyvinyl silicone impression material (Hydrorise Light, Zhermack, Italy) to mimic an alveolar socket (13). After it had polymerized, the roots were taken out. The lengths of the halves were measured by digital caliper (Liaoning MEC Group, Dalian, China), and the localizations of the resorption cavity were determined. The cavities were located 6 mm from the apex and were created with a size 8 round bur, leaving a diameter of 2.3 mm on the middle half of the roots (Fig. 1*A*). A final irrigation was applied for 1 minute by using 2 mL 17% EDTA (Ultradent, South Jordan, UT) to remove the smear layer. The root canals were then rinsed with 5 mL distilled water, dried with paper points, and put into their respective sockets in Eppendorf tubes. Twelve of the samples were randomly assigned as positive control group without any further intervention.

The apical 4 mm of the remaining 72 root canals was filled with AH Plus sealer (Dentsply De Trey, Konstanz, Germany) and F3 gutta-percha cones by using single-cone technique. The gutta-percha was partially removed with a heated plugger, leaving 4 mm of apical filling. Then the roots were divided into 6 experimental groups (n = 12) according to the filling material used in the resorption cavities and canal to coronal of the cavity as detailed below:

- Group MTA + MTA: Resorption cavities were repaired and backfilled with MTA. The powder of Angelus MTA was mixed with sterile water in a 3:1 powder/liquid ratio. The cavity repair and backfilling were performed incrementally with MTA by using hand pluggers.
- Group MTA + gutta-percha/sealer: Resorption cavities were repaired with MTA and then backfilled with gutta-percha/sealer combination. Resorption cavities were filled with MTA as described in group MTA + MTA and then backfilled with gutta-percha/AH Plus sealer combination by using warm vertical compaction with hand pluggers.
- Group Biodentine + Biodentine: Resorption cavities were repaired and backfilled with Biodentine. According to the manufacturer's instructions, 5 drops of the liquid were poured into the powder-containing capsule. The capsule was closed and triturated for 30 seconds on a mixing device. The cavity repair and backfilling were performed incrementally with Biodentine by using hand pluggers.
- Group Biodentine + gutta-percha/sealer: Resorption cavities were repaired with Biodentine and then backfilled with gutta-percha/sealer combination. Resorption cavities were filled with Biodentine

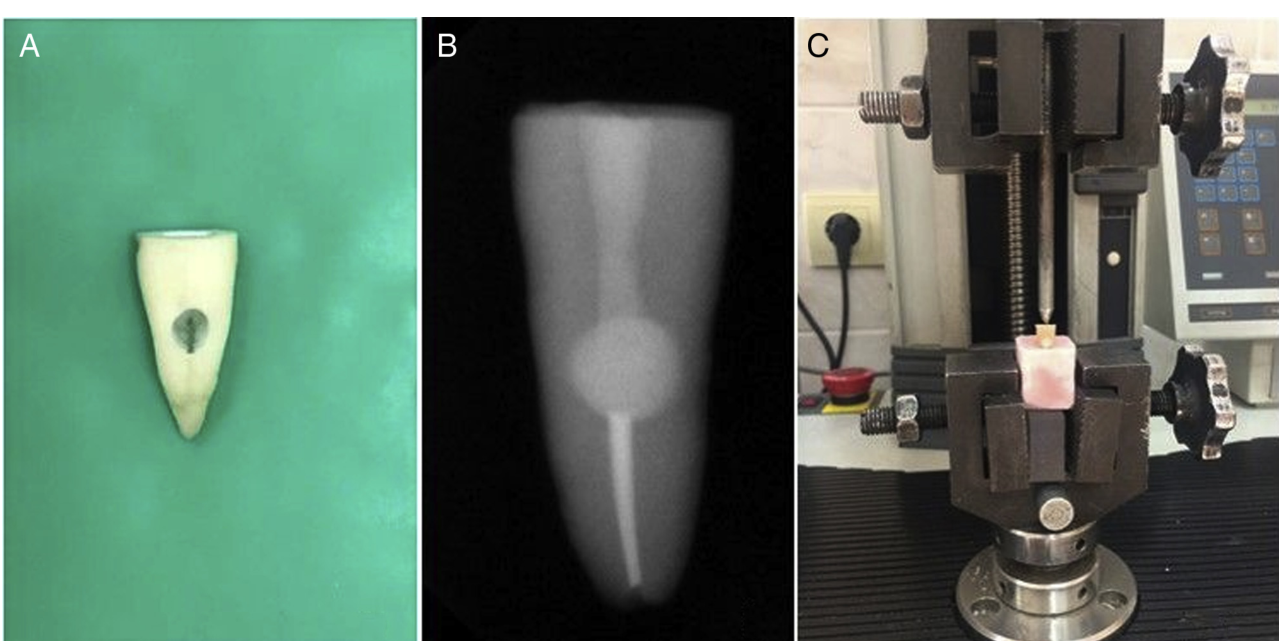

Figure 1. (*A*) Simulated perforating internal resorption cavity. (*B*) Representative radiographic image of group Biodentine + Biodentine. (*C*) Specimen placed in a universal testing machine.