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Influence of resin-based adhesive root canal fillings on the resistance to fracture of endodontically treated roots: an in vitro preliminary study

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Objective. The aim was to investigate the root reinforcing capability of the resin-based RealSeal.
Study design. In two groups (n=36) canals were instrumented with nickel-titanium rotary GTfiles or with hand K-files. Twelve teeth from each group were obturated with lateral compaction using either gutta-percha and AHPlus or RealSeal. The canals of twelve teeth of both groups were instrumented but not filled. Group 3 (n=12) acted as uninstrumented controls. The force required to fracture the roots was measured. ANOVA and Scheffé test were used for statistical analysis.
Results. The intact roots were significantly stronger than both groups with instrumented and unobturated roots ($P<.05$). Between the roots of both groups obturated with RealSeal and the intact roots there were no significant differences ($P>.05$). The roots obturated with RealSeal were significantly stronger than those obturated with gutta-percha and AHPlus ($P<.05$).
Conclusions. An obturation with RealSeal significantly increases the fracture resistance of instrumented roots. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;103:274-9)**

It is generally accepted that several endodontic treatment procedures, such as access preparation, instrumentation, and irrigation of the root canal with sodium hypochlorite (NaOCl),[1] lead to a reduction of the fracture resistance of a tooth.[2] Therefore, many attempts have been made in the past to reinforce an endodontically treated root.[3-6] Although the use of gutta-percha with an insoluble root canal sealer can be seen as the gold standard of root canal fillings, the ability of these materials to reinforce an endodontically treated root is discussed with some controversy because in some studies different root canal filling materials were able to significantly strengthen the roots,[3,6,7] whereas in other investigations these materials did not increase the fracture resistance of root-filled teeth.[4,5,8] In general it can be stated that the ability of conventional filling materials to reinforce the endodontically treated root is more then questionable owing to their inability to achieve an impervious seal along the dentinal walls of the root canal.[9,10]

Recently a new obturation material, resilon (representative brand names are Epiphany [Pentron Clinical Technologies, Wallington, CT], Next [Heraeus-Kulzer, Hanau, Germany], and RealSeal [SybronEndo, Orange, CA]) has been introduced to replace gutta-percha and conventional sealers.[11] This system comprised resilon, which is a thermoplastic synthetic core material that contains bioactive glass, bismuth oxychloride, and barium sulfate as radiopaque fillers (content of fillers approximately 65 wt%). It is claimed that the handling properties of this resilon core material are highly comparable to that of gutta-percha.[11] This system also comprised a dual-curing resin-based sealer. The matrix consists of BisGMA, ethoxylated BisGMA, urethane dimethacrylate, and hydrophilic difunctional methacrylates with a filler content of approximately 70 wt% (mainly calcium hydroxide, barium sulfate, barium

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glass, bismuth oxychloride, and silica).[11] Furthermore, this system uses a priming agent which contains a sulfonic acid–terminated functional monomer, hydroxyethylmethacrylate, water, and a polymerization initiator.[11] According to the manufacturer this system can be used with any of the most popular gutta-percha root canal obturation techniques such as lateral and vertical compaction, continuous wave, and thermoplasticized gutta-percha.

According to recent reports, this adhesive root canal filling material penetrates into the dentinal tubules of the canal wall dentin and simultaneously develops a tight adhesion between the resilon cone and the sealer.[9-11] Owing to these properties, this material forms what is called a "monoblock."[10-12] Because of this monoblock between the intraradicular dentin and the root canal filling material, the resilon-filled roots are supposed to be more resistant to both bacterial leakage[9] and root fracture[2] compared with similar roots that were filled with conventional filling materials.

The purpose of this in vitro study was to determine whether the adhesive resin-based sealer RealSeal has the ability to reinforce endodontically treated roots.

MATERIALS AND METHODS

Instrumentation and obturation

Eighty-four extracted mandibular single canal canine teeth were selected for this study. After the extraction, the teeth were stored in phosphate-buffered saline (PBS, pH 7.2) containing 0.1% sodium azide to inhibit bacterial growth for a maximum of 5 days. Coronal access was achieved using diamond burs, and the canals were controlled for apical patency with a size 10 root canal instrument. Only teeth with intact root apices, and whose root canal width near the apex was approximately compatible with size 15 were included. This was checked with silver points sizes 15 and 20 (VDW, Munich, Germany). The root length was between 15 and 18 mm, and the buccolingual diameter was between 5 and 7 mm. Soft tissue and calculus were removed from these teeth mechanically. All teeth were examined with a microscope (Leitz, Wetzlar, Germany) of 20× magnification to rule out teeth with a preexisting root fracture. All unacceptable teeth were discarded. The crowns of all acceptable teeth were sectioned with a diamond disk at the cementoenamel junction under sufficient water cooling, and the cut surface was ground flat using carborundum abrasive paper. The roots were then immersed in a 2.5% NaOCl solution for 8 h to remove any remaining pulp tissue or periodontal ligament and stored in 100% humidity (immersed in physiologic saline) until treatment.

In all groups, the roots were balanced with respect to the root length and the buccolingual diameter. The homogeneity of the experimental groups was examined with respect to the defined constraints using analysis of variance (ANOVA) with post hoc Scheffé test. The roots were assigned to the following groups:

Group 1. Thirty-six canals were instrumented by rotary nickel-titanium System GT Rotary Files (Dentsply Maillefer, Ballaigues, Switzerland) to a size 40 at the apex with the following sequence using the crown-down technique: 12/35, 10/40, 8/40, 6/40, and 4/40.

Group 2. Thirty-six canals were instrumented with stainless steel K-files (VDW) to a size 40 at the apex using a balanced force technique. No coronal flaring of the canals was performed.

Group 3. In 12 canals, no instrumentation or obturation was performed (control group).

All root canals were enlarged by only 1 operator to minimize operator variation. Otherwise, depending on the particular operator, roots may have been variably stressed with different applied lateral forces.

The working length for all groups was obtained by measuring the length of the initial instrument (size 10 K-file) at the apical foramen minus 1 mm. After each instrument, the root canal was flushed with 5 mL 2.5% NaOCl solution and at the end of instrumentation with 5 mL NaCl using a plastic syringe with a gauge 30 closed-end needle (Hawe Max-I-probe; Hawe-Neos, Bioggio, Switzerland). The needle was inserted as deep as possible into the root canal without binding. Finally, all canals were irrigated with 10 mL 17% EDTA solution which was allowed to remain in the canals for 3 min to remove the smear layer.[13] Thereafter, the canals were dried with paper points.

The rotary nickel-titanium GT instruments were set into rotation with a 4:1 reduction handpiece (WD-66 EM; W & H, Buermoos, Austria) powered by a torque-limited electric motor (Endo IT motor; VDW). For each file the individual torque limit and rotational speed programmed in the file library of the Endo IT motor were used. The rotary nickel-titanium files were used in a crown-down manner according to the manufacturer's instructions using a gentle in-and-out motion. Instruments were withdrawn when resistance was felt and changed for the next instrument.

Before the obturation of the roots, the first 2 groups were subdivided into 3 subgroups of 12 roots each. This followed a pretest sample size calculation. It has been reported that the average maximum bite force in habitual occlusion ranged between 320 N[14] and about 400 N.[15] In the present study it was estimated that a fracture resistance ranging about 25% below the maximum physiologic bite force can be assessed as a clinically