The Effect of QMix, an Experimental Antibacterial Root Canal Irrigant, on Removal of Canal Wall Smear Layer and Debris

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Abstract

Introduction: This study examined the ability of two versions of QMix, an experimental antimicrobial irrigant, on removal of canal wall smear layers and debris using an open canal design. **Methods:** Cleaned and shaped single-rooted human root canals were irrigated with NaOCl as the initial irrigant and one of the following as the final irrigant: (1) QMix I (pH = 8), (2) QMix II (pH = 7.5), (3) distilled water, (4) 17% EDTA, and (5) BioPure MTAD (Dentsply Tulsa Dental Specialties, Tulsa, OK). Smear and debris scores were evaluated in the coronal, middle, and apical thirds of longitudinally fractured canal spaces using scanning electron microscopy and analyzed using Cochran-Mantel-Haenszel statistic. **Results:** Smear scores, when the overall canal was considered, differences were observed among groups except groups 1 versus 4 and groups 2 versus 4. After adjusting for canal levels, all groups differed significantly from each other ($p < 0.005$) with the exception of groups 2 versus 5. For the debris scores, no significant difference was observed among the treatment groups when the overall canal was considered and after adjusting for the effect of canal level. **Conclusion:** Within the limitations of an open-canal design, the two experimental QMix versions are as effective as 17% EDTA in removing canal wall smear layers after the use of 5.25% NaOCl as the initial rinse. *(J Endod 2011;37:80–84)*

Key Words

Antimicrobial, canal level, chelation, debris, root canal irrigant, smear layer, surfactant

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It is impossible to create a sterile space in infected root canals with mechanical preparation alone because of the complexity of root canal systems (1–3). Pulpal tissue remnants and inorganic debris remain even in well-shaped canals, especially in those areas with which the instruments do not come in contact (4). Rotary instruments that used a conventional single-shaft design, regardless of the instrumentation technique, never contacted canal walls completely (5). The amount of residual tissues was much more in canals that were treated without irrigation than those in which root canal irrigants were used (6). Thus, irrigants are essential for successful debridement of the root canals after mechanical shaping procedures (7). Although canal wall smear layers may reduce dentin permeability and prevent bacterial penetration into dentinal tubules (8, 9), they may prevent irrigants and medications from accessing infected dentinal tubules (10). An infected smear layer containing bacteria and necrotic tissue may also act as a substrate for the multiplication of those bacteria (11, 12).

The use of NaOCl and EDTA has been reported to be effective in removing pulpal tissue remnants and the organic and inorganic components of the smear layer (13, 14). BioPure MTAD (Dentsply Tulsa Dental Specialties, Tulsa, OK), has shown promise as an antimicrobial against *Enterococcus faecalis* (15–18) and as a smear layer removal agent (19–21) after the use of 1.3% NaOCl as the initial rinse. However, the antimicrobial efficacy and substantivity of this irrigant combination has been challenged (22–24). BioPure MTAD is also relatively ineffective against *E. faecalis* biofilms (25–27), which are more difficult to eliminate and more resistant to antimicrobial agents than planktonic bacteria (28, 29). It is effective in removing canal wall smear layers but demineralizes intraradicular dentin (30).

An experimental antimicrobial root canal irrigant (QMix) and its modifications containing a mixture of a bisbiguanide antimicrobial agent, a polyaminocarboxylic acid calcium-chelating agent, saline, and a surfactant have been found to be more effective than BioPure MTAD against bacterial biofilms (Dr Markus Haapasalo, personal communication, August 2010). As little information is available on the ability of QMix in removing pulpal debris and canal wall smear layers, the objective of the present study was to evaluate its effectiveness in removing canal wall debris and smear layer from the coronal third, middle third, and apical third of root canals. The null hypothesis tested was that there are no differences in the ability of two versions of QMix, BioPure MTAD, and 17% EDTA as final irrigants to remove canal wall debris and smear layer from different parts of the root canals.

Materials and Methods

Fifty extracted human single-rooted teeth were radiographed to ensure that each tooth contained one canal and that an equal number of narrow (33%) and wide canals (67%) were present in the experimental groups. Each tooth was decoronated at 17 mm from the anatomic apex. Working length was established at 1 mm short of the apical foramen. Each tooth was prepared using a crown-down technique to size 50, 0.06 taper using the stainless steel hand files and ProTaper Universal nickel titanium rotary instruments (Dentsply Tulsa Dental Specialties).

Because the objective of the study was to evaluate the effectiveness of the irrigants instead of the efficacy of root canal irrigation (20, 21), an "open-system" design (31) with an unsealed root apex (13) that permits air and vapor communication between the

external environment and the canal space was adopted for the study. Irrigants were delivered using a 30-G side-vented needle inserted to 1 mm above the apical seat. The teeth were divided into the following five groups (n = 10) according to the types of irrigant used as the initial rinse (IR) and the final rinse (FR): (1) 5.25% NaOCl (IR), QMix solution I with pH equal to 8.0 (FR); (2) 5.25% NaOCl (IR), QMix solution II with pH equal to 7.5 (FR); (3) 5.25% NaOCl (IR), sterile distilled water (FR); (4) 5.25% NaOCl (IR), 17% EDTA (IR); and (5) 1.3% NaOCl (IR), BioPure MTAD (IR).

Sodium hypochlorite was used during canal instrumentation, and 5 mL was used as the postinstrumentation initial irrigant. The latter was delivered within 2 minutes. Five milliliters of the respective final irrigant was used and delivered within 2 minutes. The lower concentration of NaOCl used in group 5 was based on the manufacturer's instructions associated with the use of BioPure MTAD as the final irrigant.

Scanning Electron Microscopy

Two longitudinal grooves were prepared in each root without perforating the canal to facilitate splitting of each root into two longitudinal halves. The root halves were fixed in 2% glutaraldehyde, dehydrated in ascending ethanol and hexamethyldisilazane (32), sputter coated, and examined with a field emission scanning electron microscopy at 5 KeV. Twenty representative images were taken at 2,000× magnification from the respective apical (0-5 mm), middle (5-10 mm) and coronal (11-15 mm) portions of the two root halves derived from each fractured root. Only images from instrumented canal walls were taken, yielding 200 images/canal level/group.

Images were examined in a blind manner by two investigators other than the one who prepared the canals and performed scanning electron microscopy. The efficacy of smear layer removal was evaluated using a four-level scoring system based on the order of severity of smear layer retention. Canal cleanliness was evaluated using a four-level debris scoring system based on the order of severity of debris remaining on the instrumented canal wall. Criteria for these scoring systems are listed in the figure legends of Figure 1 (smear score) and Figure 2 (debris score).

Statistical Analyses

Observer Reproducibility. Twenty images of cleaned and shaped canal walls with varying degrees of canal cleanliness and smear layer removal were assessed three times in random order by the two observers at weekly intervals, each time without knowledge of the previous results. The weighted coefficient kappa (κ_w) was used to measure interobserver and intraobserver reproducibility.

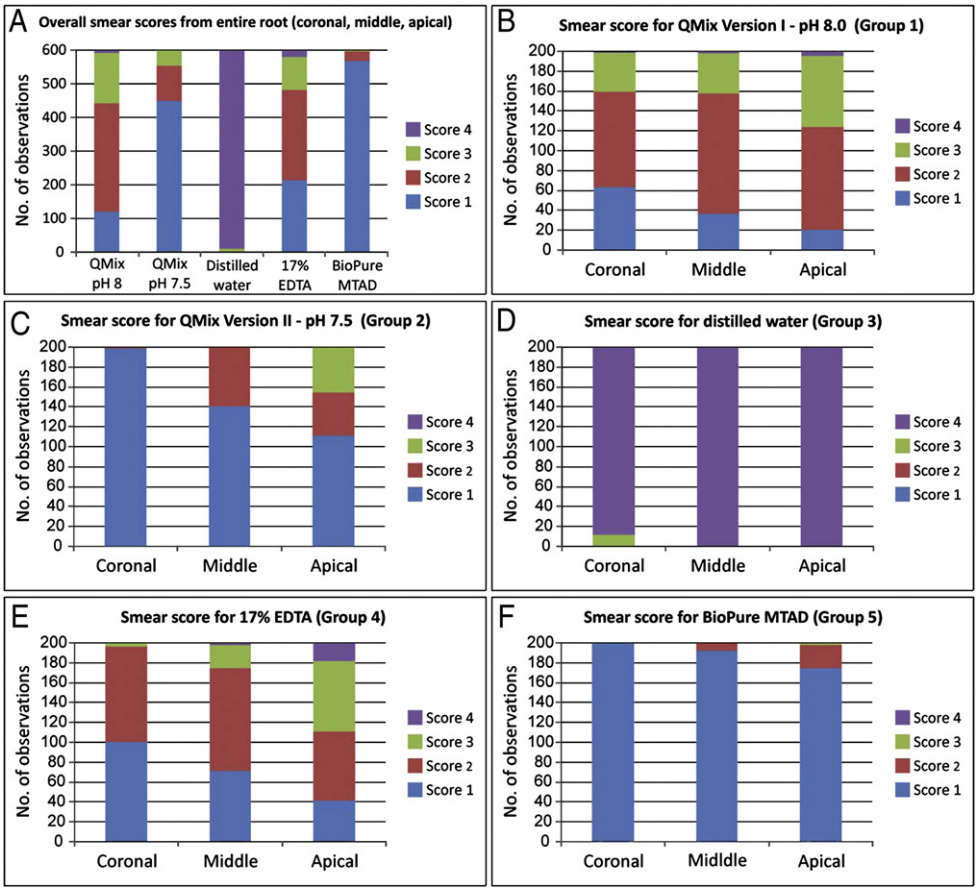

Figure 1. (*A*) Overall smear scores for the entire canal in the five groups. A four-level scoring system was used for evaluating the efficacy of smear layer removal: Score 1 = smear layer covering less than 25% of the canal wall. Most tubules were clean and patent (coronal third and middle third) or occluded with sclerotic casts (apical third). Score 2 = smear layer evident in more than 25% of the canal surface. Tubules contained debris. Score 3 = smear layer evident in more than 50% of the canal surface. Remaining tubular orifices were reduced in dimensions because of partial occlusion by debris. Score 4 = smear layer covering more than 75% of the canal surface. Very few dentinal tubules were evident. (*B*) Smear scores for groups 1 at the three canal wall levels (coronal third, middle third, and apical third). (*C*) Smear scores for group 2 at the three canal wall levels. (*D*) Smear scores for group 3 at the three canal wall levels. (*E*) Smear scores for group 4 at the three canal wall levels. (*F*) Smear scores for group 5 at the three canal wall levels.