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Effectiveness of ethylenediaminetetraacetic acid (EDTA) and MTAD on debris and smear layer removal using a self-adjusting file

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Objective. The aim of this study was to investigate the cleaning ability of a self-adjusting file (SAF) system regarding debris and smear layer removal using ethylenediaminetetraacetic acid (EDTA) or MTAD.
Study design. In total, 45 maxillary incisor teeth were randomly divided into 2 different irrigation groups of 20 canals each and a negative control group of 5 canals. The canals in each of the irrigation groups were irrigated using sodium hypochlorite (1.3%) as an initial irrigant during the first 2 minutes of operation, followed by 2 minutes continuous irrigation with either 17% EDTA or MTAD in a closed system. The negative control group was irrigated using 1.3% sodium hypochlorite. The roots were split longitudinally and subjected to scanning electron microscopy (SEM). The presence of debris and smear layer in the coronal, middle, and apical thirds of the canal was evaluated using a 5-grade scoring system with ×200 and ×2,000 magnification, respectively.
Results. The SAF operation with 2-minute continuous irrigation using MTAD resulted in root canal walls that were free of smear layer in 85%, 70%, and 60% and of debris in 95%, 90%, and 95% of the coronal, middle, and apical thirds of the root canals, respectively. The SAF operation with continuous irrigation using EDTA resulted in root canal walls that were free of smear layer in 85%, 60%, and 50% and of debris in 95%, 90%, and 85% of the coronal, middle, and apical thirds of the root canals, respectively. Teeth in the negative control group were totally covered with debris. Evaluation by SEM showed no significant difference between the tested irrigants in removing the smear layer and debris among the different regions of the root canal. Both groups were significantly different from the negative control group.
Conclusions. When using the SAF, the protocols used in this study were effective for debridement for all regions of the root canal even for the apical thirds. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112:803-808)**

Successful root canal treatment is dependent on the effective removal of bacterial biofilms and their by-products from the entire root canal system.[1] Mechanical root canal instrumentation techniques leave a layer of organic and inorganic material known as the smear layer, containing components such as odontoblast processes, necrotic tissue, bacteria, and their by-products.[2,3] Because this amorphous structure prevents the penetration of irrigants, root canal medicaments, and filling materials into dentinal tubules, debridement is essential.[4]

The dual irrigation regime of sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA) has been used for removing the debris and smear layer, resulting in successful debridement.[4] Biopure MTAD (Dentsply, Tulsa, OK), a solution of an antibiotic (tetracycline isomer [doxycycline]), acid (citric acid), and detergent (Tween 80), also results in effective debridement.[5] Because chemomechanical preparation using current instrumentation techniques does not debride the total root canal system, because of the complexity of root canal anatomy,[6,7] irrigation solutions are manda-

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tory to improve root canal cleanliness.[8] Different irrigants using varying agitation techniques have been proposed to improve the efficacy of solutions; however, conflicting results regarding the effectiveness of these solutions and techniques for removing smear layer and debris have been reported.[9] In a recent study by Tay et al.,[10] gas entrapment prevented irrigant delivery and flow 0-2 mm from the end-point of canals, calling into question the reliability of earlier studies performed with unspecified mechanisms restricting the fluid flow through the apical foramen.

Recently, a new nickel-titanium file system, the self-adjusting file (SAF; Redent-Nova, Ra'Anana, Israel) was developed to overcome the problems of conventional rotary file systems. The SAF reportedly adapts itself 3-dimensionally to the shape of the root canal and its cross-section.[11] It is attached to a special irrigation device (Vatea; Redent-Nova) and provides continuous irrigation during preparation via a silicon tube attached to a rotating hub on the shaft of the file. Continuous flow of the irrigant may have positive effects on cleaning ability, especially on the apical third of the root canal system, which remains a major problem.[12]

The present study was designed to evaluate the effectiveness of 17% EDTA or MTAD on intracanal smear layer and debris removal while using the SAF in a closed system in which 1.3% NaOCl was used as an initial irrigant.

MATERIALS AND METHODS

Selection of teeth

Forty-five human maxillary incisor teeth that had been extracted for orthodontic reasons were selected and stored in 0.1% thymol solution at 4°C until use. The age of patients was restricted to 15-20 years, because the age of the teeth affects the nature of the dentin and dentinal tubules.[13] Standard endodontic access cavity preparations were performed on the pulp chambers, and then a #15 K-type file was inserted into the canal until the tip was just visible at the apical foramen. The working length (WL) was determined at 1 mm shorter than the canal length.

Teeth were scanned with the use of cone-beam computerized tomography (I-Cat; Imaging Science, Hatfield, PA), and the diameters of the teeth were measured on the sagittal plane at the center of the coronal, middle, and apical thirds. Then teeth with similar canal anatomy were grouped in matching pairs according to their diameter sizes, because the diameter of a root canal system may affect the efficacy of the SAF instrument.

Generating the closed system

For the closed system, the apical foramen of each root was covered with the use of boxing wax before coating with hot flexible glue (Scotch Super Glue Gel; 3M, St. Paul, MN) which was solidified before embedding the roots into a clear polyvinylsiloxane impression material (Imprint II; 3M)–filled Plexiglas tube, as suggested previously.[10] Boxing wax was used to prevent the flow of the glue into the root canals. This totally closed set-up prevented irrigant extrusion from the apical foramen during canal preparation and provided continuous irrigation.

Root canal instrumentation and irrigation with the SAF

Teeth with matching diameters were divided into 2 experimental groups, each containing 20 teeth, and 1 negative control group of 5 teeth. In group 1 (EDTA group), 1.3% NaOCl + 17% EDTA was used, and in group 2 (MTAD group) 1.3% NaOCl + MTAD was used as an irrigant and chelating agent throughout the 4-minute operation using the SAF.

A glide path was established by manual instrumentation up to a size 20-K file, as suggested previously[11]; however, apical gauging with increasing sizes of ProTaper hand files (Dentsply-Maillefer, Ballaigues, Switzerland) revealed apical sizes to be #30 or #35 for the maxillary incisors, which rendered meaningless the size #20 used during manual instrumentation.

The SAF was operated using an in-and-out vibrating handpiece, as described by Metzger et al.[11] and Peters et al.[14] at 5,000 vibrations/min and a 0.4-mm amplitude, using an irrigation device (Vatea) until it reached the predetermined WL. All roots were prepared by 1 operator (A.Ö.) in the following sequences:

- EDTA group: The SAF file was used in 2 cycles of 2 minutes each (total 4 min). NaOCl was used as the irrigant during the first cycle, and 17% EDTA during the second cycle.
- MTAD group: The SAF file was used in 2 cycles of 2 minutes each (total 4 min). NaOCl was used as the irrigant during the first cycle, and MTAD during the second cycle.
- Negative control group: The SAF file was used for 4 minutes using only 1.3% NaOCl.

The flow rate of the irrigants was set at 5 mL/min, resulting in a total volume of 10 mL of each final irrigant solution. After completion of the 2 cycles, a final rinse using 10 mL distilled water was delivered with a 30-G Max-I-Probe needle (Dentsply, Surrey, U.K.) to 1 mm short of the WL. The root canal was dried using paper points, and the tooth was left to dry at room temperature for 24 hours before being prepared for scanning electron microscopy (SEM) examination.