Influence of Root Canal Taper on Its Cleanliness: A Scanning Electron Microscopic Study

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Abstract

Introduction: Taper is a factor that determines final root canal dimensions and, consequently, the dimensions of the space for the cleaning action of irrigants. Therefore, the aim of the present study was to investigate the influence of taper on root canal cleanliness. **Methods:** Root canals of 45 mandibular incisors were divided into 3 groups and prepared with GT rotary files to apical preparation size 30 and final taper 0.04, 0.06, and 0.08, respectively. Irrigation with 2.5% NaOCl was performed after each file. The final irrigation sequence was 10 mL 17% ethylenediaminetetraacetic acid, followed by 10 mL 2.5% NaOCl and 10 mL saline solution. The presence of debris and smear layer on root canal walls was evaluated under the scanning electron microscope with the use of a 4-category scale system. **Results:** The presence of debris was minimal in all groups. Statistical analysis for the presence of smear layer showed no significant differences between the groups, whereas a significant difference was detected between the apical and middle thirds of each group. **Conclusions:** Under the conditions of this study, root canal preparation with tapers 0.04, 0.06, or 0.08 did not affect canal cleanliness. Debris removal was almost complete for all tapers, whereas smear layer was not removed, especially from the apical part of the canals. *(J Endod 2011;37:871–874)*

Key Words

Debris, EDTA, root canal preparation, root canal taper, rotary NiTi instruments, smear layer

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After its mechanical preparation, root canal is a space where the irrigation fluids are placed to express their cleaning action. The dimensions of this space determine the irrigants' volume and, consequently, their efficacy. In 1965, Wandelt (1) stated that only a small and ineffective volume of a chelator can be placed in narrow root canals. In a recent study, Brunson *et al* (2) confirmed Wandelt's statement, showing that an increase in root canal dimensions leads to an increase in the mean volume of irrigant inside the canal. The clinician has the ability to alter root canal dimensions by changing the final apical preparation size and/or its taper.

In the era of ISO manufactured endodontic instruments, keeping the apical preparation as wide as possible was believed to be the only way for the irrigation fluids to reach and reduce the microbial population from the critical apical 3 mm of the root canal, thus increasing its cleanliness (3–7). Today, the manufacturers of nickel-titanium rotary systems believe that apical preparation should be kept as narrow as possible while increasing root canal taper. This decreases the preparation errors and makes root canal obturation easier and more efficient, but it also creates a greater deposit for the irrigation fluids and at the same time leads to cutting a larger amount of dentin from the canal walls, thus producing a cleaner root canal (8). Although this hypothesis seems reasonable, it has little scientific evidence; it is not yet proven whether an increase in taper leads to cleaner root canals. In a recent study, Brunson *et al* (2) showed that the increase in apical preparation size and taper leads to an increase in mean irrigant volume inside the canal. However, these investigators did not study the effect of increased irrigant volume on root canal cleanliness. Therefore, the purpose of the present study was to investigate the influence of taper on root canal cleanliness, which was assessed by the presence of debris and smear layer in the middle and apical thirds of canals prepared with 3 different tapers. The null hypothesis was that the increase in taper does not affect root canal cleanliness.

Materials and Methods

Forty-five freshly-extracted mandibular incisors stored in 10% formalin were used for this study. Before preparation, all teeth were radiographed in buccolingual direction to ensure they had 1 straight root canal. The teeth were cut perpendicularly to their long axis by using a diamond disk 10 mm from the root tip. Patency of the root canals was ensured by using #10 K-file (Dentsply/Maillefer, Ballaigues, Switzerland). Finally, a small amount of Carbowax (Dow Chemical Co, Midland, MI) was placed on each root tip.

The roots were randomly divided into 3 experimental groups (n = 15). Root canal instrumentation was performed with GT rotary files Series 20 and 30 (Dentsply/Maillefer), placed in the handpiece of an Endo IT motor (Aseptico, Woodinville, WA) with programmed torque control and speed settings. Different protocols were used in a way that final root canal taper was 0.04, 0.06, and 0.08 for groups A, B, and C, respectively. Working length was 9 mm. The instrumentation details were as follows.

In group A (taper 0.04), GT files Series 30 were used in a crown-down manner. Files 30/0.10, 30/0.08, and 30/0.06 were placed 2, 5, and 7 mm inside the canal, respectively, and file 30/0.04 at working length. In g roup B (taper 0.06), root canals were instrumented as in group A, and at the end of preparation, files 20/0.08 and 30/0.06 were placed at working length. In g roup C (taper 0.08), root canals were instrumented as in group B, and at the end of preparation, files 20/0.10 and 30/0.08 were placed at working length.

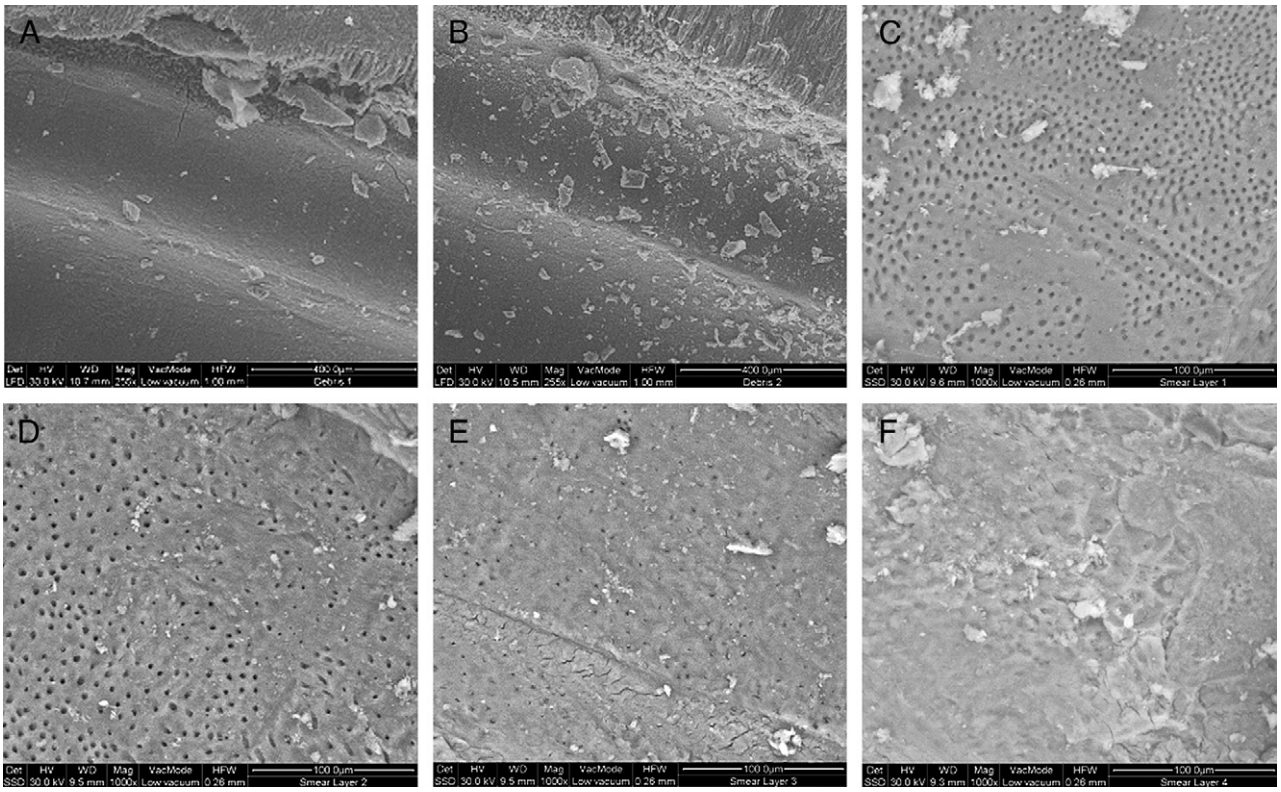

Figure 1. Representative scanning electron microscopy photos of debris and smear layer scores. (*A*) Debris score 1; (*B*) debris score 2; (*C*) smear layer score 1; (*D*) smear layer score 2; (*E*) smear layer score 3; (*F*) smear layer score 4. No representative photos of debris scores 3 and 4 were taken because no root canal surface covered by debris more than 50% was found. This was explained to the examiners before scoring.

Between every file change, patency at working length was confirmed by using #10 K-file, and the canals were irrigated with 2.5% NaOCl. Irrigation was performed with a 27-gauge blind-ended endodontic irrigation needle (Hawe Max-I-probe; Kerr-Hawe, Bioggio, Switzerland). The volume of irrigant flushed after each file was 3 mL for group A, 2 mL for group B, and 1.5 mL for group C. The final irrigation sequence was 10 mL of 17% EDTA (Vista Dental Products, Racine, WI) for 3 minutes, followed by 10 mL of 2.5% NaOCl and 10 mL saline solution. The total amount of irrigants used in each canal was 42 mL.

After instrumentation the roots were split longitudinally with a diamond disk in a buccolingual direction. The presence of debris and smear layer was evaluated by scanning electron microscopy at 255× and 1000× magnification, respectively. A 4-category scale system was used for debris and smear layer as follows: score 1, presence of debris/smear layer that covers 0%–25% of the surface examined; score 2, presence of debris/smear layer that covers 25%–50% of the surface examined; score 3, presence of debris/smear layer that covers 50%–75% of the surface examined; and score 4, presence of debris/smear layer that covers 75%–100% of the surface examined.

Representative photos of each score taken in a pilot study were given to the examiners before scoring (Fig. 1).

The scoring procedure was performed by 3 examiners and was double-blinded. First, the apical end of preparation was found at low magnification, and then every millimeter of the apical (0–3 mm) and middle (4–6 mm) thirds of the root canal wall was scanned at 255× and 1000× magnification and scored.

Statistical analysis with the nonparametric Kruskal-Wallis test was performed to detect any statistical differences in the presence of debris and smear layer between the 3 groups. In addition, the nonparametric Friedman test was used to assess the differences between the apical and middle thirds of the root canals of each group. The level of significance was set at $P \leq .05$.

Results

Debris

The presence of debris in the apical and middle thirds of the root canals was found to be minimal, with a mean score of 1.1 for all groups. For this reason, debris was excluded from the statistical analysis.

Smear Layer

Mean scores for the presence of smear layer in groups A, B, and C are shown in Table 1. No statistically significant differences could be found between the groups. However, a statistically significant difference between the apical and the middle thirds was detected in all groups, with the former showing the worst results (Table 2).

Discussion

The objective of the present study was to evaluate the influence of taper on root canal cleanliness. To achieve this, the canals studied should have the same apical preparation size but different tapers. Therefore, the experimental protocol for the use of System GT files was

TABLE 1. Mean Scores for the Presence of Smear Layer

	Group A	Group B	Group C
Mean score ± standard error	3.3 ± 0.14	3.2 ± 0.2	3.08 ± 0.17

No statistically significant differences were found between the groups ($P > .05$).

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