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A scanning electron microscopic study of debris and smear layer remaining after using AET and ProTaper instruments

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Aim. To compare *in vitro* the cleanliness of root canal walls following the use of two automated instrumentation techniques.

Methodology. Thirty extracted human maxillary central incisors, maxillary and mandibular canines and premolars with single root canals were examined in this study. The teeth were divided into two groups. In group 1 (20 teeth), automated canal preparation was performed using Anatomic Endodontic Technology (AET). In group 2 (10 teeth), root canals were prepared with ProTaper nickel titanium (NiTi) rotary instruments. Irrigation was performed using alternately 3.00% NaOCl and 18% EDTA, followed by rinsing with saline. The roots were split longitudinally into halves and the canals examined using a scanning electron microscope. The presence of a debris and smear layer was recorded at the coronal, middle and apical thirds of root canals using a four-step scoring scale. Mean scores for debris and smear layers were calculated and statistically analysed for significance ($p < 0.05$) between and within the groups, using the Mann–Whitney–Wilcoxon and Friedman nonparametric tests.

Results. Under the conditions of this study, the removal of superficial debris and smear layers was generally good with both canal preparation techniques. However, both techniques resulted in variable presence of residual superficial debris and smear layers. Statistical analysis showed that there was no significant difference between the experimental groups in all thirds of root canals for a superficial debris and smear layer ($p > 0.05$). Comparison of the removal of the smear layer among the three regions showed that in AET group there was a statistically significant difference among all parts, especially between the middle and apical thirds ($p < 0.005$). Overall, the middle sections were cleaner than the coronal and apical ones.

Conclusions. Complete cleanliness was not achieved by any of the techniques and instruments investigated. It may be inferred that the choice between AET and ProTaper instrumentation should be based on factors other than the amount of root canal debridement, which does not vary high significantly according to the instruments used.

Key words: Anatomic Endodontic Technology, cleaning efficacy, EDTA, endodontics, ProTaper, root canals, root canal instrumentation, scanning electron microscopy, sodium hypochlorite

INTRODUCTION

Although thorough cleaning and shaping of the root canal system are considered as key requirements for success in root canal treatment, numerous investigations have demonstrated the limitation of manual and automated root canal instrumentation regarding the overall quality of preparation (1–3). All endodontic instruments create dentine debris and a smear layer as a consequence of their action on root canal walls (4, 5). This debris may be compacted along the entire surface of canal walls, increasing the risk for bacteria 'contamination' and reducing the adaptation of sealer and gutta-percha (6). Furthermore, this debris may be compacted apically and create an apical plug that prevents the complete filling of this important region (7). It is also important that endodontic instruments remove dentine and pulpal debris from the entire root canal wall and create a canal free from bacteria. These problems have resulted in a wide search for innovative materials, instruments, and techniques to obtain a clean, disinfected, debris-free canal for obturation (8).

Since most hand preparation techniques are time consuming, technically demanding and may lead to iatrogenic errors (ledging, zipping, canal transportation and apical blockage), much attention has been directed toward

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automated root canal preparation techniques and especially nickel–titanium (NiTi) rotary instruments. Numerous studies have reported they could efficiently create a smooth, predetermined funnel-form shape, with minimal risk of ledging and transporting the canals (9–11). Shaping procedures can be completed more easily, quickly and predictably, but effective cleansing of the entire root canal system using Ni–Ti rotary instruments has not yet been demonstrated (12). The basic problem with all rotary systems is that rotary instruments are centered in root canals during rotation and leave uncleaned areas and potentially infected tissues in fins and isthmus after preparation.

The ProTaper NiTi rotary system is based on a unique concept and comprises just six instruments – three shaping files and three finishing files. These instruments were designed by Dr. Cliff Ruddle, Dr. John West, and Dr. Pierre Machtou. The ProTaper cross-sectional design resembles that of a reamer, with three sharp cutting edges, convex core and no radial lands.

Recently, an innovative concept of mechanical root canal preparation, the Anatomic Endodontic Technology (AET) has been introduced (13). AET was specifically designed to maintain the natural shape of the root canal during preparation. The manufacturer claims that this system is intended to minimize the number of steps and instruments required for effective preparation of root canals.

Numerous studies have been reported on the relative effectiveness of different instrumentation techniques, based on a variety of ways of evaluating canal debridement. Outcomes of instrumentation differ depending on the method of canal preparation and evaluation, each method showing advantages and disadvantages (14). Introduction of the scanning electron microscope (SEM) has proved to be a valuable method for assessment of the ability of the endodontic procedures to remove debris from root canals, thus enabling comparison of instruments and techniques. Therefore, a number of studies about the debridement of the root canal wall have been carried out by using SEM (15, 16, 17, 18) However, as far as we know, only a few studies on specifically testing the AET instrumentation for canal debridement have been carried out (13).

The aim of the present study was to compare, by means of scanning electron microscopy, the presence of a smear layer and remnants of debris on the walls of root canals after preparation with AET instruments and ProTaper instrumentation.

MATERIALS AND METHODS

Thirty freshly extracted single-rooted maxillary central incisors, maxillary and mandibular canines and premolars with closed apices were used. None of the teeth had received restorative or endodontic therapy. Following extraction, the teeth were stored in isotonic saline solution to avoid any effect that a fixative might have on the dissolution of organic tissue. Conventional endodontic access cavities were prepared (Endo Access Bur, Dentsply Maillefer, Ballaigues, Switzerland) in a high-speed handpiece. To determine the working length, a size 10 K-file was inserted until it reached the apical foramen and one millimetre was subtracted from this length. A small amount of wax was placed on the tip of each root to prevent irrigating solutions from passing through the apical foramen.

Canal instrumentation

The teeth were divided into two groups: group 1 (20 teeth) was instrumented with AET instruments (Ultradent Products Inc., South Jordan, UT, USA) and group 2 (10 teeth) was instrumented with ProTaper NiTi instruments (Dentsply Maillefer, Ballaigues, Switzerland). The procedures used for each instrumentation group were standardized.

In group 1, the canals were prepared using the AET (Ultradent Products Inc., South Jordan, UT, USA) according to the manufacturer's instructions. The operative procedures were as follows. The coronal two-thirds were enlarged with Shaping files 1, 2 and 3. Initially, a size 1 shaping file (2.5% taper) was inserted by hand to approximately 4 mm of the established working length. The file was then used in a reciprocating 4 : 1 low-speed handpiece and the canal was instrumented to the same length at ±250 rpm and a side-to-side / up-and-down motion. Intermittently, three to four times, the file was used in a slight lifting motion whilst stroking to facilitate the outward removal of debris. With each stroke, the file was reinserted exerting a buccal to lingual cutting pressure on the outstroke. In teeth in which the mesial and distal aspects provided no resistance, the file was lightly wiped against these walls for a few seconds. For the final preparation of the canals, the Apical files 1, 2 and 3, which only cut in the apical area and have a 2.5% taper, were then used by hand to the working length by a step-back technique. Files were changed to the next size when no resistance was felt. Preparation of the apical third of the canals was judged complete when the size 3 Apical file (equivalent to a size 30 K-file at the tip) could be inserted to the working length without force.

In group 2, the canals were prepared with ProTaper instruments according to the manufacturer's direction. The root canal that had already been enlarged to a size 15 K-file was progressively instrumented with ProTaper instruments. S1 was taken into the canal just short of the depth at which the hand file was taken previously. Then, the shaping SX instrument was used to move the coronal aspect of the canal away from furcal danger and to improve radicular access. This step was continued with the SX until about two-thirds of the overall lengths of the cutting blades were below the orifice. This was followed by using S1 and then S2 to length. The finishing of the canals was performed until F3 reached the full WL. Maximum effort was made to take the files to length only one time, and for no more than 1 s. The preparation was performed using a low-torque control motor (Tecnika; ATR, Pistoia, Italy).

In all groups, individual instruments were discarded after use in each root canal and irrigation was performed after each change of instrument using 2.0 ml of a 3.0% NaOCl solution (ChlorCid, Ultradent Products, Inc., South Jordan, Utah, USA) followed by 2.0 ml of a 18% EDTA solution (Ultradent Products, Inc., South Jordan, Utah, USA) and a final rinse with 2.0 ml saline. During instrumentation, the canals were flushed with the irrigation solutions using disposable syringes and 30-gauge needles which were placed at approximately 3–4 mm from the working length without binding. Upon completion of instrumentation the needles could be placed at approximately 2–3 mm from the working length, and the root was finally flushed for 1 min with 2.0 ml of 18% EDTA solution, washed with 2.0 ml of 3.0% NaOCl solution followed by copious rinsing with 4.0 ml saline. Finally the canals were dried with paper points. After preparation, the specimens were stored in 100% relative humidity at 37 °C until further use.

SEM examination

The crowns were removed at the amelo-cemental junction using a fissure bur in a highspeed handpiece. To facilitate fracture into two halves, all roots were grooved longitudinally on the buccal and lingual surfaces with a small round diamond bur, avoiding penetration into the cavity. Finally, the roots were split with a small chisel into two halves. The two halves were dehydrated in a graded series of ethanol solutions, critical point dried, attached to coded stubs, sputter-coated with 10% gold-palladium and observed with a scanning electron microscope (Stereoscan 100, Cambridge, England, UK). Photomicrographs at ×200 (for debris score) and ×1000 (for the smear layer) were taken in the apical, middle and coronal thirds of the canals.

Specimen grading

Separate blind evaluations were undertaken by two trained observers for debris and smear layer using reference photographs.

Superficial debris and smear layer were independently subjected to a standardized semiquantitative evaluation in four grades according to the classification of Gutmann et al. (1994)(19). Criteria for the scoring were the following:

Score of the superficial debris (Fig. 1): (a) score 1, little or no superficial debris covering up to 25% of the specimen; (b) score 2, little to moderate debris covering

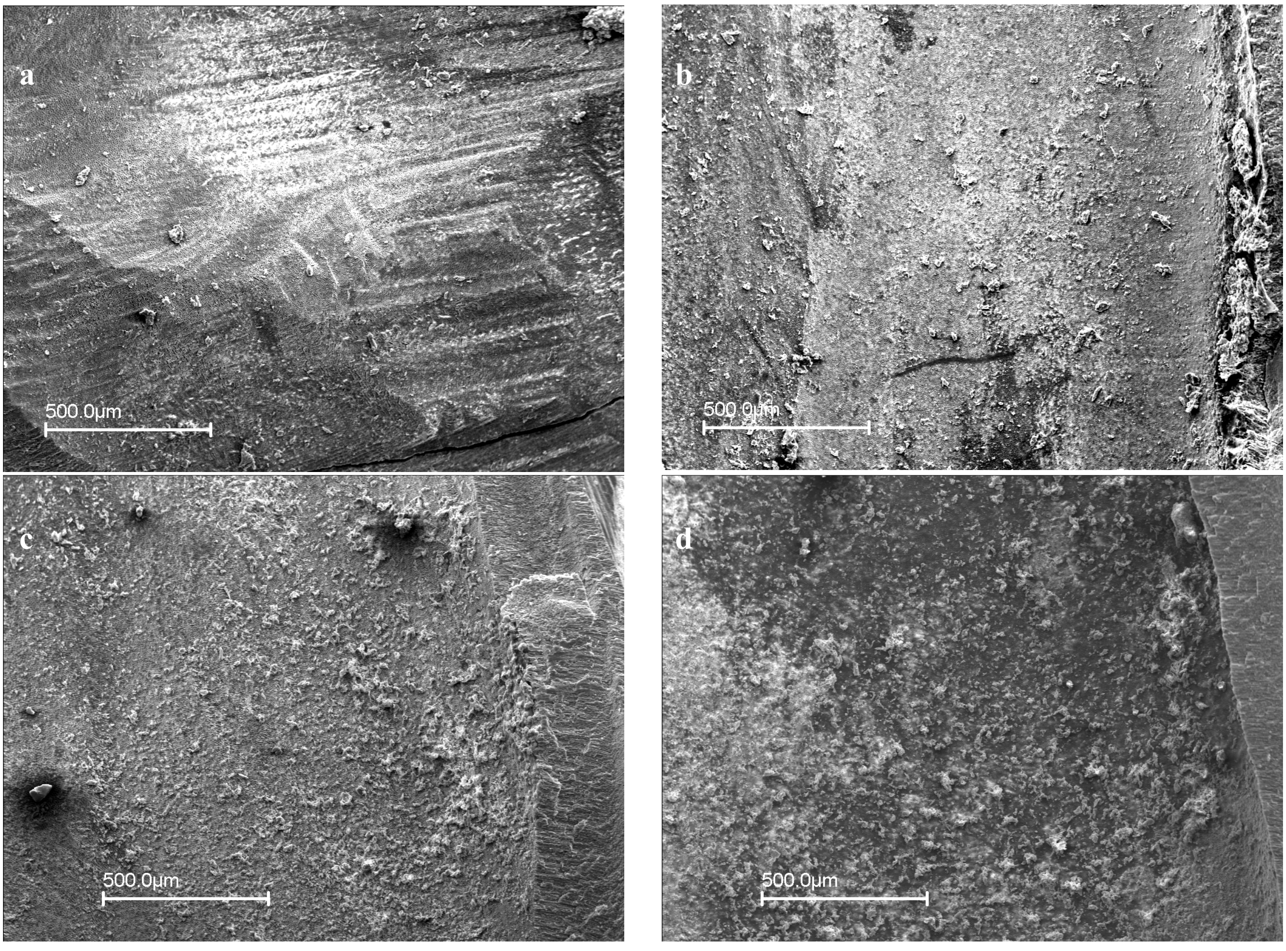

Fig. 1. Standardized gradations of superficial debris used for specimen evaluation. a – score 1; b – score 2; c – score 3; d – score 4. Original magnification ×200

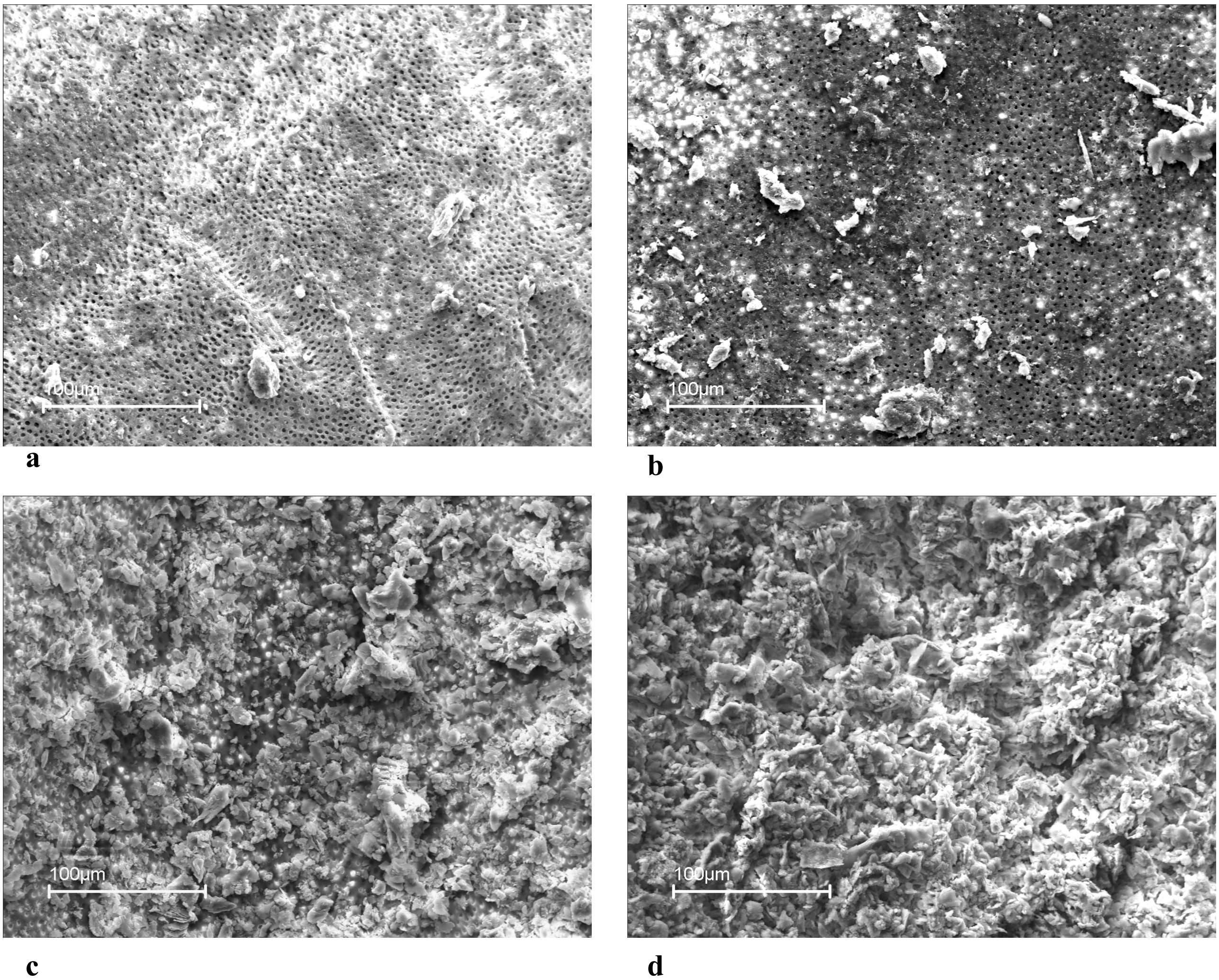

Fig. 2. Standardized gradations of smear layer used for specimen evaluation. a – score 1; b – score 2; c – score 3; d – score 4. Original magnification ×1000

between 25 and 50% of the specimen; (c) score 3, moderate to heavy debris covering between 50 and 75% of the specimen; and (d) score 4, heavy amounts of aggregated or scattered debris over 75% of the specimen.

Score of the smear layer (Fig. 2): (a) score 1, little or no smear layer; covering less than 25% of the specimen; tubules visible and patent; (b) score 2, little to moderate or patchy amounts of smear layer; covering between 25 and 50% of the specimen; many tubules visible and patent; (c) score 3, moderate amounts of scattered or aggregated smear layer; covering between 50% and 75% of the specimen; minimal to no tubule visibility or patency; and (d) score 4, heavy smear layering covering over 75% of the specimen; no tubule orifices visible or patent.

Evaluation

Scoring was performed in the coronal, middle and apical thirds of each longitudinal half of the root. For superficial debris, 9 microscopic fields at ×200 were randomly assessed in each third of each half-root and 9 fields at ×1000 were, respectively, examined for the smear layer. Each field was graded from 1 to 4 according to the scoring system, and the mean value was calculated for each region of each half of the root.

A preliminary series of four teeth not included in this study served for training and calibration of the procedure, both for the operator and observers. Four photomicrographs, taken as representative of the fourgrade scoring system for both superficial debris and smear layer, served as visual reference standards throughout the evaluation. Each examiner assigned his score independently of the other.

The data on the score levels were recorded directly onto coding sheets and transferred to a desktop computer. The statistical analyses were carried out by means of nonparametric tests (Mann–Whitney–Wilcoxon test among the groups and Friedman test within the groups). A probability value equal to or less than 0.05 was considered to indicate significance.

RESULTS

At ×200 and ×1000 magnification the instrumented canal walls from both groups appeared smooth and exhi-

Table 1. **Mean differences in the superficial debris score between groups**

Group	Third of the root canal	Mean score	SD	P value
AET		1.8200	0.4999	
	coronal			$p > 0.05$
ProTaper		1.8325	0.5513	
AET		1.5780	0.2388	
	middle			$p > 0.05$
ProTaper		1.36	0.6049	
AET		1.7475	0.3494	
	apical			$p > 0.05$
ProTaper		2.148	0.4378	

Table 2. **Mean differences in the smear layer score between groups**

Group	Third of the root canal	Mean score	SD	P value
AET		2.4145	0.4404	
	coronal			$p > 0.05$
ProTaper		2.186	0.6864	
AET		2.1602	0.3431	
	middle			$p > 0.05$
ProTaper		2.55	0.8215	
AET		2.6277	0.3240	
	apical			$p > 0.05$
ProTaper		3.2385	0.3633	

Table 3. **Scores of superficial debris within groups**

Group	Third of the root canal	Mean score	SD	P value
	coronal	1.8200	0.4999	
AET	middle	1.5780	0.2388	0.18966
	apical	1.7475	0.3494	
	coronal	1.3925	0.5513	
ProTaper	middle	1.36	0.6049	0.74082
	apical	2.148	0.4378	

Table 4. **Scores of smear layer within groups**

Group	Third of the root canal	Mean score	SD	P value
	coronal	2.4145	0.4404	
AET	middle	2.1602	0.3431	0.00063
	apical	2.6277	0.3240	
	coronal	2.186	0.6864	
ProTaper	middle	2.55	0.8215	0.34130
	apical	3.2385	0.3633	

bited varying amounts of remaining debris and smear layer along the entire length of the root canal. The mean scores of debris and smear layer between the groups recorded in the coronal, middle and apical thirds are shown in Tables 1 and 2, respectively. Tables 3 and 4 show the mean scores of debris and smear layer in different thirds within experimental groups. However, no completely clean root canals were found in any group.

Superficial debris

In AET instrumentation group the removal of superficial debris appeared more effective in the middle than in the coronal and apical parts of the root, but this was not statistically significant. In ProTaper instrumentation group the removal of superficial debris appeared more effective in the apical than in the coronal and middle parts of the root, but this was not statistically significant by the Friedman test. No statistically significant difference ($p > 0.05$) was noted between the two instrumentation techniques concerning the amount of supperficial debris.

Smear layer

Few surfaces showed smear layer to be absent and dentinal tubules completely patent (Fig. 3). Amongst the groups, the Mann–Whitney–Wilcoxon test displayed not statistically significant differences at all the three levels of the roots ($p > 0.05$). The AET-prepared teeth showed a lower score at the middle third (2.1602 AET vs. 2.288 ProTaper instrumentation), but this was not statistically significant. Smear layer removal at the coronal third was slightly more effective with ProTaper instrumentation (score 2.3815 vs. AET 2.4145), but did not differ significantly according to the same statistical test. Smear layer removal at the apical third was slightly more effective with ProTaper instrumentation too (score 2.5285 vs. AET 2.6277), however, this was not statistically significant ($p > 0.05$).

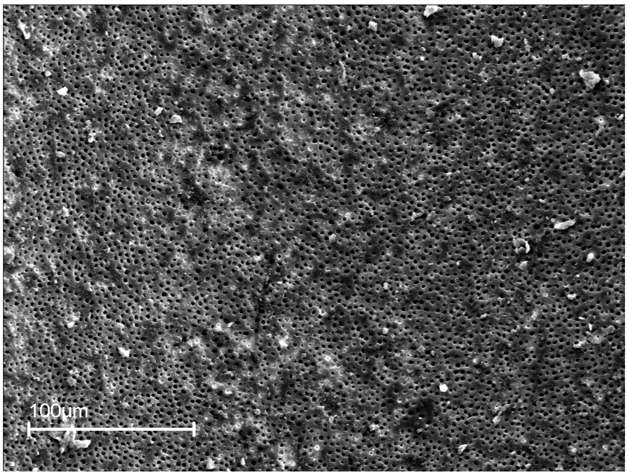

Fig. 3. Mid-root section showing a dentinal surface with minimal smearing. ProTaper-prepared specimen. Original magnification ×1000

Statistically significant differences for smear layer debridement among the thirds of the root were evident in the AET group where the smear layer removal was more effective in the middle third and worst in the apical third. In the ProTaper group, smear layer removal was more effective in the middle third and worst in the apical third too, but this was not statistically significant.

DISCUSSION

Neither of the instrumentation techniques achieved total debridement of the root canal, with both debris and smear layer remaining on the dentinal walls. This finding is supported by earlier reports (15). One source of bias in studies of this kind is the selection of teeth, i.e. identical shapes of root canals in natural teeth are almost impossible to obtain. However, it is essential to use natural teeth in studies such as this (20).

The main advantage of SEM is that it allows evaluation of both halves of the canal wall along their entire length. However, only the surface can be examined, and the depth of debris cannot be determined precisely. Preparation of the specimen may also induce artefacts (15). Moreover, there are practical limitations for grading the root canal surface when a scoring system is used. In fact, magnification is a compromise between the need to observe large areas of the root internal surface, yet still maintaining the possibility of identifying specific structures. This considered, it is estimated that a sufficiently representative view of the debridement of the root canal was achieved in the present study. One weakness of the evaluation of the micrograph was that the measurements of debris and smear layer were arbitrary and at best ordinal in nature. However, there is currently no consensus in the standardization of measurements of debris and smear layer.

It should be emphasized, as with most *in vitro* studies, that a degree of caution should be exercised in the interpretation of the findings and their clinically extrapolation (21). Many variables were encountered in the clinical and experimental techniques used in the literature, i.e. freshly extracted or saline- or formalin-stored teeth, instrumentation following decoronation or through a clinical access cavity, different irrigating solutions and / or procedures. This makes every comparison impossible and could account for the apparent conflict in results (17).

It was not possible to determine whether this incomplete debridement occurred because of the nature of the experimental model. Mastering any new endodontic technique is undoubtedly related to the individual's learning curve (22), however, our results cannot be explained by operator inexperience, since he had been practising ProTaper instrumentation as well as AET instruments for a significant period prior to this study. Indeed, incomplete debridement appears to be a common problem of SEM investigations (15), which have generally concluded that all hand and mechanical instrumentation and irrigation methods leave debris, both organic and inorganic, within the canal (23). The present findings are in agreement with these observations, demonstrating that untouched dentinal surfaces are usually left, and the aim to provide the optimum cleanliness of the root canal is a theoretical one. Indeed, smear layer removal still remains a controversial issue (24), and, since many other bio-mechanical factors may affect the outcome of root canal treatment, further studies are needed to establish the clinical importance of its absence or presence (25). In this respect, irrigating solutions and procedures appear more critical than instrumentation techniques. More important factors to be considered are the speed and ease of use, canal shaping ability, reduced apex transportation, and the reliability of instruments under mechanical stress.

Overall, at the coronal and middle levels, the canals prepared with ProTaper appeared to have less surface contamination compared with using AET instrumentation. However, some isolated areas of unprepared root canal walls were also present in the ProTaper and AET instrumentation groups. There are several reasons that may explain why root canals shaped with new generation AET instruments have low debris and smear layer scores (close to canals shaped by ProTaper instrumentation). The AET technique was performed with stainless steel instruments used in a 30° reciprocating side-to-side and up-and-down motion. These instruments are stiffer than nickel–titanium rotary instruments and can be easier and with less risk forced towards the root canal walls and the polar recesses during the side-to-side lifting motion. The use of stainless steel instruments in this motion was probably more efficient in following the natural shape of the canals and removing tooth structure (13). This also yielded a larger preparation with an increased volume of irrigants in direct contact with the root canal walls. However, the taper of ProTaper instruments is greater than AET files. This can explane why ProTaper instruments remove superficial debris and smear layer better than do AET instruments (especially in the middle and apical regions).

Another important fact to be emphasized is that efficient cleaning does not necessarily depend only on the type of instrument or instrumentation technique used. In order to dissolve debris and smear layer, chemical irrigation solutions are recommended along with mechanical instrumentation (26–28). Baumgartner & Mader (29) found that alternating solutions of EDTA with NaOCl were the most effective combination to produce clean root canal walls. Their study demonstrated the importance of using a chelating agent such as EDTA in combination with NaOCl in order to effectively remove the inorganic and organic components of the smear layer. Therefore, in this study 2.0 ml of 3.0% NaOCl and 2.0 ml of 17% EDTA was used in an effort to maximize the cleansing of the instrumented canal walls, although perhaps not universally recommended. It can be argued that the use of 2.0 ml saline as a final rinse was not necessary, at least for this study. However, the authors believe that this was an important step to rid the canal of chemicals that had been previously used. To eliminate variables, equal volumes of irrigants were used for all teeth. A potential variable that may have affected the results for all groups is that the use of irrigants appeared to be less effective in areas that were not or partially instrumented.

Although the time required to prepare the root canals in each group was not recorded, it was our impression that the AET technique was simpler and less time-consuming.

CONCLUSIONS

Complete cleanliness was not achieved by any of the techniques and instruments investigated. Whether this translates into a clinically more successful treatment cannot be determined from this study. It may be inferred that the choice between AET and ProTaper instrumentation should be based on factors other than the amount of root canal debridement. More important factors to be considered are the speed and ease of use, canal shaping ability, reduced apex transportation, and the reliability of instruments under mechanical stress.Within the limitations of this study, however, the use of AET is promising and warrants further laboratory experiments and clinical trials.

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References

1. Hülsmann M, Stryga F. Comparison of root canal preparation using different automated devices and hand instrumentation. Journal of Endodontics 1993; 19: 141–5.
2. Hülsmann M, Rümmelin C, Schäfers F. Root canal cleanliness after preparation with different endodontic handpieces and hand instruments. A comparative SEM investigation. Journal of Endodontics 1997; 23: 301–6.
3. Bertrand MF, Pizzardini P, Muller M, Médioni E, Rocca JP. The removal of the smear layer using the Quantec system. A study using scanning electron microscope. International Endodontic Journal 1999; 32: 217–24.
4. Torabinejad M, Hanysides R, Khademi AA, Bakland LK. Clinical implication of the smear layer in endodontics: a review. Oral Surgery, Oral Medicine, Oral Pathology Radiology and Endodontics 2002; 94: 658–66.
5. Jeon IS, Spänberg LSW, Yoon TC, Kazemi RB, Kum KY. Smear layer production by 3 rotary reamers with different cutting blade design in straight root canals: a scanning electron microscopic study. Oral Surgery, Oral Medicine, Oral Pathology Radiology and Endodontics 2003; 96: 601–7.
6. Bowman CJ, Baumgartner JC. Gutta-percha obturation of lateral grooves and depressions. Journal of Endodontics 2002; 28: 220–3.
7. Iqbal MK, Maggiore F, Suh B, Edards KR, Kang J, Kim S. Comparison of apical transportation in four NI-Ti rotary instrumentation techniques. Journal of Endodontics 2003; 29: 587–91.
8. Yang SF, Rivera EM, Walton RE, Baumgartner KR. Canal debridement: effectiveness of sodium hypochlorite and calcium hydroxide as medicaments. Journal of Endodontics 1996; 22: 521–5.
9. Esposito PT, Cunningham CJ. A comparison of canal preparation with Nickel–Titanium and Stainless Steel instruments. Journal of Endodontics 1995; 21: 173–6.

10. Short JA, Morgan LA, Baumgartner JC. A comparison of canal centering ability of four instrumentation techniques. Journal of Endodontics 1997; 23: 503–7.
11. Thompson SA, Dummer PMH. Shaping ability of ProFile.04 Taper Series 29 rotary nickel–titanium instruments in simulated root canals. Part 2. International Endodontic Journal 1997; 30: 8–15.
12. Siqueira JF Jr, Araśjo PFG, Garcia PF, Fraga RC, Sabóia Dantas CJ. Histological evaluation of the effectiveness of five instrumentation techniques for cleaning the apical third of root canals. Journal of Endodontics 1997; 23: 499–502.
13. Zmener O, Pameijer CH, Banegas G. Effectiveness in cleaning oval-shaped root canals using Anatomic Endodontic Technology, ProFile and manual instrumentation: a scanning electron microscopic study. International Endodontic Journal 2005; 38: 356–63.
14. White M. Endodontic system conserves canal anatomy with minimally invasive techniques. Dental Town Magazine 2002; 3: 26–30.
15. Heard F, Walton RE. Scanning electron microscope study comparing four root canal preparation techniques in small curved canals. International Endodontic Journal 1997; 30: 323–31.
16. Mizrahi S, Tucker J, Seltzer S. A scanning electron microscopic study of the efficacy of various endodontic instruments. Journal of Endodontics 1975; 1: 324–333.
17. Cameron JA. Factors affecting the clinical efficiency of ultrasonic endodontics: a scanning electron microscopy study. International Endodontic Journal 1995; 28: 47–53.
18. Lloyd A, Jaunberzins A, Dummer PMH, Bryant S. Rootend cavity preparation using the MicroMega Sonic Retroprep TipTM. SEM analysis. International Endodontic Journal 1996; 29: 295–301.
19. Gutmann JL, Saunders WP, Nguyen L, Guo IY, Saunders EM. Ultrasonic root-end preparation Part 1. SEM analysis. International Endodontic Journal 1994; 27: 318–24.
20. Ahlquist M, Henningsson O, Hultenby K, Ohlin J. The effectiveness of manual and rotary techniques in the cleaning of root canals: a scanning electron microscopy study. International Endodontic Journal 2001; 34: 533–7.
21. Thompson SA, Dummer PMH. Shaping ability of lightspeed rotary nickel–titanium instruments in simulated root canals. Part 1. Journal of Endodontics 1997; 11: 698–702.
22. Barbakow F, Lutz F. The „Lightspeed“ preparation technique evaluated by Swiss clinicians after attending continuing education courses. International Endodontic Journal 1997; 30: 46–50.
23. Cunningham WT, Martin H, Forrest WR. Evaluation of root canal debridement by endosonic ultrasonic synergistic system. Oral Surgery, Oral Medicine and Oral Pathology 1982; 53: 401–4.
24. Liolios E, Economides N, Parissis-Messimeris S, Boutsioukis A. The effectiveness of three irrigating solutions on root canal cleaning after hand and mechanical preparation. International Endodontic Journal 1997; 30: 51–7.
25. Sen BH, Wesselink PR, Turkun M. The smear layer: a phenomenon in root canal therapy. International Endodontic Journal 1995; 28: 141–8.
26. Hülsmann M, Rümmelin C, Schäfers F. Root canal cleanliness after preparation with different endodontic handpieces and hand instruments: a comparitive SEM Investigation. International Endodontic Journal 1997; 23: 301–6.
27. Peters OA, Barbakow F. Effects of irrigation on debris and smear layer on canal walls prepared by two rotary techniques: a scanning electron microscopic study. Journal of Endodontics 2000; 26: 6–10.
28. Mayer BE, Peters OA, Barbakow F. Effects of rotary instruments and ultrasonic irrigation on debris and smear layer scores: a scanning electron microscopic study. International Endodontic Journal 2002; 35: 582–9.
29. Baumgartner JC, Mader CL. A scanning electron microscopic evaluation of four root canal irrigation regimens. Journal of Endodontics 1987; 13: 147–57.

Saulius Drukteinis, Irena Balčiūnienė

ŠAKNIES KANALO PAVIRŠINIO IR LIPNIOJO SLUOKSNIŲ, LIEKANČIŲ NAUDOJANT AET BEI ProTaper INSTRUMENTUS, TYRIMAS SKENUOJANČIU ELEKTRONINIU MIKROSKOPU

S a n t r a u k a

Darbo tikslas. Palyginti *in vitro* šaknies kanalo sienelės užterštumą panaudojus dvi mašininių endodontinių instrumentų sistemas (AET ir ProTaper).

Metodika. Tyrime naudota 30 vienašaknių išrautų žmogaus viršutinio žandikaulio centrinių kandžių, viršutinio ir apatinio žandikaulių ilčių bei kaplių. Dantys atsitiktine tvarka suskirstyti į dvi grupes. I grupės (20 dantų) šaknų kanalai preparuoti naudojant anatominės endodontinės technologijos (AET) instrumentus. II grupės (10 dantų) dantys preparuoti naudojant ProTaper nikelio titano (NiTi) rotacinius instrumentus. Šaknų kanalų irigacijoms naudoti 3,00 NaOCL ir 18% EDTA tirpalai, galiausiai kanalas iriguotas fiziologiniu tirpalu. Šaknys padalytos į dvi dalis ir šaknies kanalų paviršiaus užterštumas tirtas skenuojančiu elektroniniu mikroskopu (SEM). Paviršinis užterštumo sluoksnis bei lipnusis sluoksnis buvo tiriami bei fiksuojami vainikiniame, viduriniame ir viršutiniame šaknies trečdaliuose. Užterštumo vertinimui naudota 4 balų vertinimo skalė. Paviršinio užterštumo bei lipniojo sluoksnio duomenų vidurkių statistinė analizė tarp grupių bei jų viduje atlikta naudojant Mann-Whitney-Wilcoxon ir Friedman neparametrinius testus.

Rezultatai. Mūsų tyrimo rezultatai rodo, kad naudojant abi technikas paviršinis bei lipnusis sluoksniai nėra visiškai pašalinami. Statistinės analizės duomenimis, šaknies kanalo užterštumo lygmuo tarp eksperimentinių grupių skirtinguose šaknies trečdaliuose nėra statistiškai patikimas ($p > 0,005$). Lyginant lipniojo sluoksnio pašalinimo efektyvumą tarp skirtingų šaknies kanalo trečdalių paaiškėjo, kad pirmoje (AET) grupėje jis skiriasi statistiškai patikimai, ypač tarp vidurinio ir viršūninio trečdalių ($p < 0,005$). Apskritai vidurinis šaknies trečdalis (lyginant su vainikiniu ar viršūniniu trečdaliais) lieka mažiausiai užterštas abiejose grupėse.

Išvados. Nė viena tirta šaknies kanalo instrumentavimo technika neužtikrina visiško paviršinio bei lipniojo sluoksnių pašalinimo, todėl gydytojo pasirinkimą tarp AET ir ProTaper instrumentų turėtų nulemti ne tik paviršinio bei lipniojo sluoksnių pašalinimo efektyvumas, bet ir kiti svarbūs kriterijai, tokie kaip naudojimo paprastumas ir minimalios laiko sanaudos, minimali šaknies kanalo transportacija ar instrumentų atsparumas mechaninėms jėgoms bei lūžiams.

Raktažodžiai: anatominė endodontinė technologija, EDTA, ProTaper, endodontija, šaknų kanalai, skenuojantis elektroninis mikroskopas, natrio hipochloritas