Last Generation Endodontic Instruments. A Study of their Efficacy in Apical Shaping

M. Siragusa, DDS, PhD, and G. Racciatti, DDS

Drs. Siragusa and Racciatti are affiliated with the Department of Endodontics, Faculty of Dentistry, National University of Rosario. Dr. Siragusa is the Director of the Postgraduate Career of Specialization in Endodontics at the Faculty of Dentistry, National University of Rosario.

Running title: Apical Shaping by Modern Instruments

Keywords:

Address correspondence to:

Martha Siragusa

Mitre 465 – 8º A

2000 – Rosario. Santa Fe - Argentina

Tel/fax: 0341-4244012

E-mail: msiragus@arnet.com.ar

ABSTRACT

One of the aims of surgical preparation is to remove pulp tissue and shape the root canal to access the apical foramen. The aim of the present study was to evaluate the efficacy of manual and rotary instruments versus stainless steel instruments in cleaning and shaping. Sixty-five lower premolars with curvatures that did not exceed 25° were assigned to 6 groups. Coronal-apical preparation techniques were employed. The samples were longitudinally abraded and observed in a stereomicroscope at x40 magnification and by SEM. The best results were observed in Groups 6 (rotary Pro File) and 4 (Pro File 29) as compared to Group 2 (stainless steel). The present results reveal that very few of the surgical preparations achieved complete removal of tissues, debris and microorganisms. It is difficult to guarantee complete removal, particularly in clinical practice.

INTRODUCTION

Some of the main aims of surgical preparation are to remove pulp tissue and eliminate microorganisms from the root canals (American Association of Endodontists 1998) and shape the canal to access the apical foramen. This is difficult to achieve with conventional, stainless steel instruments in curved and narrow canals (Weine F et al. 1975). Many flexible nickel-titanium endodontic files seem to be more effective in minimizing the complications associated with the preparation of curved canals, in particular in the case of engine-driven instruments (Glosson C et al. 1995).

Rotary instruments must be driven by mechanical systems with great torque at only a few revolutions per minute.

The first rotary systems were introduced by Wildey and Senia in 1989 and were originally called Master Canal Systems. These systems were modified, resulting in today´s nickel-titanium Lightspeed instruments. The high percentage of fractures is a disadvantage of engine-driven instruments (Zuolo M & Walton R 1997). Inadequate use of the instruments increases the percentage of fractures, particularly in the case of Lightspeed instruments. The design of these files allows for curved canals to remain well centered and reduces apical transportation (Knowles K et al. 1996) (Wildey W & Senia E 1989). These instruments are engine-driven and operate at 750 to 2000 r.p.m.

A new generation of endodontic instruments characterized by a constant increase in Taper appeared in 1991. These Pro File 29 files are manual and the stainless steel and nickel-titanium types have been on the market since 1993 (Schilder H 1993). Their inactive tip reduces step formation in curved canals (Lyng JH 1995). Their caliper increases at a constant rate of 29.7%. According to Schilder (Schilder H 1993), the Pro File 29 series has 2 advantages over the rest of the endodontic instruments. Sizing is more appropriate, with a larger amount of instruments at the beginning of the series than at the end. It takes less instruments to get from a narrow instrument to a large caliper one. The Pro File rotary series is manufactured in nickel-titanium by Maillefer-Dentsply and are operated at low speed (150 to 350 r.p.m.). Many authors report that the cleaning efficacy of manual versus engine-driven instruments is greater (Hülsmann M et al. 1997) (Schhwarse T et al. 1996). However, other studies showed that rotary nickel-titanium instruments allow for better preparation of curved canals (Biishop K & Dummer PMH 1997) (Thompson SA & Dummer PMH 1997). Partially instrumented areas have been found in all the canals prepared with manual or rotary files (Bolanos O & Jensen J 1980). Engine-driven instruments lead to the formation of a thicker smear layer than manual instruments (Schhwarse T & Geurtsen W 1996). Schäfer reports that rotary Pro File instruments allow for better

instrumentation, particularly in curved canals (Schäfer E & Zapke K 2000).

The aims of the present study were to analyze the cleaning and shaping capacity of these last generation instruments as compared to standard, stainless steel instruments.

MATERIALS AND METHODS

Sixty-five lower premolars with curvatures that did not exceed 25° were selected for this study. Once their external surface had been cleaned thoroughly, the specimens were stored in saline solution until use.

The specimens were assigned to 6 groups:

Group 1: Canal with no preparation (negative control).

Group 2: Canals prepared with standard stainless steel instruments (positive control). (Maillefer-Dentsply).

Group 3: Canals prepared with Golden Medium instruments (positive control). (Maillefer-Ballaigues).

Group 4: Canals prepared with Pro File 29 instruments (manual). (Tulsa Dental Products, Tulsa, OK).

Group 5: Canals prepared with Lightspeed instruments (rotary). (Technology Inc.).

Group 6: Canals prepared with Pro File Rotary Systems 0.04-0.06. (Maillefer-Dentsply).

Access cavities were prepared using profuse irrigation with 5% sodium hypochloride and hydrogen peroxide (10 volumes). The working lengths were set by deducting 1 mm from lengths recorded when the tips were visible at the apical foramina. The canals were prepared with corono-apical techniques employing the different instruments under study. Irrigation was performed alternatingly with 5% NaOCl and H_2O_2 (10 volumes) and lastly, with distilled water. After cleaning and shaping the canals, the samples were abraded longitudinally to allow for evaluation of the lingual half. All the specimens were examined in a stereomicroscope at x40 magnification and in a scanning electron microscope and evaluated at the coronal, middle and apical levels. The quality of cleaning and shaping was recorded as: Excellent, Good, Acceptable or Insufficient according to the following definitions:

Excellent (E): clean dentin walls.

Good (G): canals with small clumps of debris.

Acceptable (A): canals with larger amounts of residual matter.

Insufficient (I): canals with abundant smear layer.

The data were submitted to statistical analysis.

RESULTS

In the present study we assessed the efficacy of 3 different last generation instruments in apical cleaning and shaping.

Table 1 shows the data for preparations performed with standard, stainless steel type K smooth files as positive controls. In these preparations the apical third was cleaner than the rest of the canal.

Table 2 shows the data for preparations performed with Golden Medium files. Their cleaning capacity was very poor, in particular in the apical third.

Table 3 shows the data for the preparations performed with files whose caliper increases at a constant rate of 29.7%. The results were good for 90% of the cases in the apical third. Their cleaning capacity was better in the middle and coronal thirds.

Table 4 corresponds to the preparations performed with the rotary Lightspeed files. Only 50% of the specimens were considered “Good” in the apical third. Their cleaning capacity was significantly greater in the apical third than at the coronal level.

Table 5 shows the data for the rotary Pro File 0.04-0.06 instruments. The quality of tissue removal was better along the full length of the canals.

Figures 1-8 show the percentage incidence of the different categories of preparation quality (E, G, A or I) for the different observation levels.

SEM data reveal that the best results in terms of apical cleaning and shaping were obtained for Group 6 (rotary) and Group 4 (manual), as compared with the control group in which the canals were prepared with stainless steel files. Analysis by SEM shows that Lightspeed files leave abundant debris in the apical third of the canal (Fig. 9). The findings for Golden Medium files were similar, i.e. pulp remnants were observed.

DISCUSSION AND CONCLUSIONS

Last generation manual and rotary endodontic instruments were developed to minimize apical transportation and deformation induced by rigid stainless steel instruments.

Keeping in mind the main aims of root canal preparation postulated by Schilder, the design of the ideal instrument is still lacking.(Ingle JI & Bakland LK 2000)

In the present study we performed a comparative analysis of the quality of preparations achieved with manual and rotary instruments. In the conditions of the present study, very few preparations achieved complete removal of tissues, debris and microorganisms. These instruments would not guarantee successful preparations.

Schäfer and Zapke (2000) reported that the Rotary Pro File 0.04-0.06 System afforded better results than the manual or automatic systems. Our data are in keeping with that study. However, our data would also confirm the findings of Barbakow and Peters (2000) who reported that the efficacy of rotary systems may be insufficient for oval canals.

From the results of the present study we may conclude that complete debridement of root canals is difficult to guarantee, particularly in clinical practice.

The authors thank Dr. Amanda Schwint for his help with manuscript translator.

REFERENCES

American Association of Endodontists, ed., (1998) Glossary: Contemporary terminology for endodontics. 6th. ed. Chicago: American Association of Endodontists.

Bishop K, Dummer PMH (1997) A comparison of stainless steel Flexofiles and nickel-titanium NiTiFlex files during the shaping of simulated canals. *International Endodontic Journal* **30**, 25-34.

Bolanos O, Jensen J (1980) Scanning electron microscope comparisons of the efficacy of various methods of root canal preparation. *Journal of Endodontics* **6**, 815-22.

Glosson C, Haller R, et al. (1995) A comparison of root canal preparations using Ni-Ti hand, Ni-Ti engine-driven, and K-Flex endodontic instruments. *Journal of Endodontics* **21**, 146-51.

Hülsmann M, Rümmelin C, et al. (1997) Root canal cleanliness after preparation with different endodontic handpieces and hand instruments: a comparative SEM investigation. *Journal of Endodontics* **23**, 301-6.

Ingle JI, Bakland LK. (2000) *Endodoncia,* 4th edn Mc Graw-Hill Interamericana.

Knowles K, Ibarrola J, et al. (1996) Assessing apical deformation and transportation following the use of Lightspeed root-canal instruments. *International Endodontic Journal* **29**, 113-7.

Lyng JH (1995) An evaluation of new dimensional file designs on canal preparation. Master's Thesis, Minneapolis, University of Minnesota.

Peters O, Barbakow F (2000) Effects of irrigation on debris and smear layer on canal walls prepared by two rotary techniques: a scanning electron microscopic study. *Journal of Endodontics* **26** (1):6-10.

Schäfer E, Zapke K (2000) A comparative scanning electron microscopic investigation of efficacy of manual and automated instrumentation of root canals. *Journal of Endodontics* **26** (11):660-4.

Schäfer E, Zapke K (2000) A comparative scanning electron microscopic investigation of efficacy of manual and automated instrumentation of root canals. *Journal of Endodontics* **26** (11):660-4.

Schwarse T, Geurtsen W (1996) Comparative qualitative SEM study of automated vs. hand instrumentation of root canals. Dutsch Zahnärztl Z; **51**, 227-30.

Schwarse T, Geurtsen W (1996) Comparative qualitative SEM study of automated vs. hand instrumentation of root canals. Dtsch Zahnärztl Z; **51**, 227-30.

Schilder H (1993) Revolutionary new concepts in endodontic instruments sizing. *Journal of Endodontics* **7**, 166-72.

Schilder H (1993) Revolutionary new concepts in endodontic instruments sizing. *Journal of Endodontics* **7**, 166-72.

Weine F, Kelly R, Lio P (1975) The effect of preparation procedures on the original canal shape and on apical foramen shape. *Journal of Endodontics* **1**, 255-62.

Wildey WL; Senia ES (1989) A new root canal instrument and instrumentation technique: a preliminary report. *Oral Surgery* **67**, 198-207.

Wildey WL; Senia ES (1989) A new root canal instrument and instrumentation technique: a preliminary report. *Oral Surgery* **67**, 198-207.

Thompson SA, Dummer PMH (1997) Shaping ability of ProFile .04 taper series 29 rotary nickel-titanium instruments in simulated canals. Parts 1 and 2. *International Endodontic Journal* **30**, 1-15.

Zuolo M, Walton R (1997) Instrument deterioration with usage: nickel-titanium versus stainless steel. *Quintessence International* **28**, 397-402.

K - F I L E			
SPECIMEN	**CORONAL THIRD**	**MIDDLE THIRD**	**APICAL THIRD**
Specimen 1	A	G	G
Specimen 2	G	A	G
Specimen 3	A	A	A
Specimen 4	A	G	G
Specimen 5	I	I	I
Specimen 6	G	A	G
Specimen 7	I	I	A
Specimen 8	A	A	A
Specimen 9	I	A	A
Specimen 10	I	I	A

Table 1: Categories of canals instrumented manually with smooth K-Files.

GOLDEN MEDIUM			
SPECIMEN	**CORONAL THIRD**	**MIDDLE THIRD**	**APICAL THIRD**
Specimen 1	I	I	I
Specimen 2	I	A	A
Specimen 3	G	G	G
Specimen 4	A	A	I
Specimen 5	G	A	I
Specimen 6	I	I	I
Specimen 7	I	I	I
Specimen 8	I	I	I
Specimen 9	A	A	A
Specimen 10	A	I	I

Table 2: Categories of canals instrumented manually with Golden Medium Files.

PRO FILE 29			
SPECIMEN	**CORONAL THIRD**	**MIDDLE THIRD**	**APICAL THIRD**
Specimen 1	G	G	G
Specimen 2	G	G	G
Specimen 3	G	G	G
Specimen 4	I	I	G
Specimen 5	A	A	G
Specimen 6	I	I	I
Specimen 7	I	I	G
Specimen 8	G	G	G
Specimen 9	G	G	G
Specimen 10	G	G	G

Table 3: Categories of canals instrumented manually with ProFile 29 Files.

LIGHT SPEED			
SPECIMEN	**CORONAL THIRD**	**MIDDLE THIRD**	**APICAL THIRD**
Specimen 1	A	G	A
Specimen 2	I	G	G
Specimen 3	A	I	A
Specimen 4	I	I	A
Specimen 5	I	I	I
Specimen 6	I	I	G
Specimen 7	I	I	A
Specimen 8	A	A	G
Specimen 9	A	A	G
Specimen 10	I	A	G

Table 4: Categories of canals instrumented manually with Lightspeed Files.

PRO File .04 - .06			
SPECIMEN	**CORONAL THIRD**	**MIDDLE THIRD**	**APICAL THIRD**
Specimen 1	B	E	B
Specimen 2	B	B	E
Specimen 3	E	B	B
Specimen 4	I	B	E
Specimen 5	A	B	E
Specimen 6	B	B	I
Specimen 7	A	I	E
Specimen 8	E	B	E
Specimen 9	A	A	I
Specimen 10	E	E	B

Table 5: Categories of canals instrumented manually with rotary ProFile 0.04 - 0.06 Files.

LEGENDS TO FIGURES

Fig. 1: Percentage of categories at coronal, middle and apical levels.

Fig. 2: Percentage of categories at coronal, middle and apical levels.

Fig. 3: Percentage of categories at coronal, middle and apical levels.

Fig. 4: Percentage of categories at coronal, middle and apical levels.

Fig. 5: Percentage of categories at coronal, middle and apical levels.

Fig. 6: Comparative analysis of the quality of preparation achieved with the 5 different instruments at the coronal level.

Fig. 7: Comparative analysis of the quality of preparation achieved with the 5 different instruments at the middle level.

Fig. 8: Comparative analysis of the quality of preparation achieved with the 5 different instruments at the apical level.

Fig. 9: SEM images of the apical third for the different groups. From left to right and from top to bottom: negative control group, preparations performed with stainless steel, Golden Medium, ProFile 29 (manual), Lightspeed or ProFile 0.04-0.06 files.