A comparison of preparing curved canals using NiTi Engine-driven and K-flexo endodontic instruments

Jamal A. Mahdi B.D.S., M.Sc.
Iman M. Al-Zaka B.D.S., M.Sc.
Haider H. Jasim B.D.S., M.Sc.

Abstract

The purpose of this in vitro study was to evaluate the combined effect of ProTaper file rotary instruments to K-flexo file hand instruments in curved canals in terms of instrumentation time, change in working length, and spreader penetration depth. Thirty curved mesial canals of extracted mandibular molars were used in this study, divided into two groups (15) canals for each group. In group I the canals were prepared with NiTi ProTaper file with slow speed contra angle hand piece (300rpm). In group II the canals were prepared by step-back technique with Gates-Glidden using stainless steel K-flexo hand instruments. Students't-test revealed that there was a highly significant difference between group I and group II in preparation time, and change in working length. In group II spreader penetrated significantly closer to working length than in group I.

Key words:Rotary instruments, ProTaper file, instrumentation, K-flexo file

Introduction

One objective of root canal instrumentation is to clean and shape the root canal system to form a continuously tapered preparation from the coronal access to the apical foramen [1,2]. This shape provides enough space for irrigants that are important to complete the cleaning and allows the placement of spreader and effective root filling [2]. Canal shaping is relatively easy in straight roots but has always been challenging, demanding a high skill, when performed in curved roots [3]. This difference is a result of the stiffness of stainless steel files, which are unable to follow canal curvatures without developing high lateral forces responsible for canal aberrations and loss of working length[4].

In recent years, Nickel-Titanium (NiTi) alloy manual and rotary endodontic instruments have revolutionized endodontics. With the creation of these super-elastic NiTi instruments, achieving a correct canal shape, even in curved canals, appears to be more predictable and safe. Several studies demonstrate that, compared with instrumentation by stainless steel files, NiTi mechanical preparation are more centered in the canal lumen, rounder and better maintained in their original anatomy [5,6].

Once the value of the NiTi for endodontic applications was established, research was directed toward the study of various systems, able to reduce the number of files necessary for the working sequence and, at the same time, to lower the risk of file separation. This trend has leaded to the introduction to the market many of NiTi rotary instruments that are different in taper and blade design. ProTaper file is the latest NiTi rotary products that available know in the market. ProTaper files introduce a new design with progressively increasing tapers with a multiple taper in a single instrument, Triangular section, active blades, and a moderately active tip (7). The ProTaper system consists of shaping and finishing instruments that allow for even, safer shaping of the root canal system (7).

Obturation of canals prepared with NiTi rotary instruments may be achieved using a variety of thermo-plasticized or lateral condensation techniques (8). To take advantage of the more uniform canal preparation produced by rotary files, progressively increasing tapers gutta-percha cones have been developed. These master cones are manufactured to have matching master apical sizes and taper of rotary NiTi file system. Bal et al.(8) found that Filling with a master cone with a larger taper may be advantageous in that a larger and more uniform mass of gutta-percha is introduced that potentially has less sealer entrapped in the filling mass, but less spreader penetration was observed with 06 tapered master cone than 02 tapered master cone.

The purpose of this in vitro study was to compare the preparation time, working length change, and spreader penetration depth in the curved canals prepared either by NiTi ProTaper file or Stainless Steel K-flexo files.

Materials and methods

Forty mandibular curved molars were used in this study. All teeth were scaled with a periodontal scaler to remove soft tissue and calculus, and then radiographically evaluated for the degree of curvature according to Schneider technique (9). Thirty mesial canals with curvatures ranging from 20 to 30 degrees were chosen. Using a diamond disc bur with straight handpiece and water coolant, the coronal portion of the teeth were removed to eliminate the variables in the access preparation, as well as to standardize the length of the root (which should be 14 mm from the apex to the coronal end). The selected tooth were randomly divided into two groups of (15) canals each. The first group was prepared with rotary endodontic instrument ProTaper (Dentsply Maillefer, Switzerland) using high torque contra angle handpiece (INTRA surg500, Kavo, Germany) at speed of (300rpm). Each set of rotary instrument prepared of 3 canals. The range for using rotary instruments properly without any defects was recorded between 3-5 canals (10, 11).

The second group was prepared with stainless-steel K-flexo file (Maillefer, Switzerland) instrument using step-back technique. Copious irrigation with 2.5% NaOCL was performed repeatedly after each instrument. During the instrumentation, apical patency filing and recapitulation were performed frequently with K-flexo files. All canals were prepared to a working distance of 13 mm, and the final apical preparation was set to #30.

Canal preparation

Group 1: All canals were prepared mechanically with the ProTaper system (Maillefer, Ballaigues, Switzerland) a system made up of six instruments. According to the manufacturer's recommendations, using a low speed hand piece (300rpm) with crown- down technique, For coronal portion of the canal start with shaping file S1 (Purple colored) to achieve straight line access with brushing movement once resistance felt remove the file and force against the canal walls on its removal, this action performed just to remove any cervical interference. After that shaping file SX is used with the same manner. When the canal is patent and working length is confirmed shaping file S1 is reused to the working length with brushing motion, followed by shaping file S2 (white colored ring) used with the same manner till it reached the working length, followed by irrigation and recapitulation. The apical portion is prepared with finishing files, first start with F1 file (yellow ring) to working length followed by F2 file (red ring) to the working length. Finally use F3 file (blue ring) is used to working length its tip size equal to #30 file, with that instrument the preparation of the apical portion is completed.

Group 2: was prepared with step-back technique. Apical preparation was performed using stainless steel 0.02 taper K-flexo files to the working length. Size 15 K-flexo file was inserted and placed to the working length with a combination of filing and reciprocal reaming action until it fit loosely in the canal. This was repeated with successive larger files until the apical portion of the canal was instrumented to # 30. Step-back were performed to 1 mm short of the previous file size until the mid-canal area was instrumented to # 60. Gates-Glidden drills # 2 to # 4 were used to create coronal and mid root preparation.

Measurement techniques

Preparation time

The time for canal preparation was recorded in seconds. This included the total active instrumentation, irrigation, recapitulation, and the time taken even when changing the instruments.

Change in working length

Final length of each canal was measured after preparation. A # 30 K-flexo file was inserted into the prepared canal, and its length was measured with vernier (scaled 0.05 mm). Any changes in working length were determined by subtracting the final length from the original length.

Spreader penetration depth

After instrumentation was complete, the canals were dried with paper points. ZOE sealer (Dorifil, Dorident) was mixed according to the manufactures instructions, and a thin layer was applied to the preparation walls with a file one size smaller than the master apical file.

In group (I): F3 gutta-percha size was placed in the canal to the working length. Finger spreader was inserted along side the master cone and the distance of the spreader tip from the working length was measured by subtracting the depth of spreader penetration from the working length in each canal.

In-group (II): the same procedure for group 1 was repeated using ISO #30 master cone gutta-percha gutta-percha.

Statistical analysis

Independent (T) tests were used to compare group I to group II in each of the three measurement technique.

Results

Preparation time

The mean preparation time to prepare the canals is shown in table (1). There was a very highly significant differences between group I and II ($P<0.001$) table (2).

Change in working length

The mean loss of working length is shown in table (1). In group I was 0.21 mm, in group II was 0.46 mm. A very highly Significant loss of working length took place in the step-back with K-flexo hand instruments (P<0.001) table (2) fig. (1).

Spreader penetration depth

The depth of spreader penetration, as measured by the distance of spreader from the full working length, was 2.75 mm and 1.13 mm in group I and II, respectively. The differences in spreader penetration between the two groups was highly significant (P<0.01) table (2) fig. (1).

Table (1): Descriptive statistics for experimental groups

Measurement techniques		No. of canals	Mean	S.D
Preparation time (sec)	Group I	15	288.66	33.446
	Group II	15	794.933	14.002
Loss working length (mm)	Group I	15	0.21	0.188
	Group II	15	0.46	0.163
Spreader penetration depth (mm)	Group I	15	2.75	0.552
	Group II	15	1.13	0.480

Table (2): Student's t-test

Measurement techniques	Comparison groups	Df	T	P-value	C.S.
Preparation time (sec)	I vs. II	14	-56.056	P<0.001	***
Loss working length (mm)	I vs. II	14	12.876	P<0.001	***
Spreader penetration depth (mm)	I vs. II	14	-5.129	P<0.01	**

**highly significant
***very highly significant

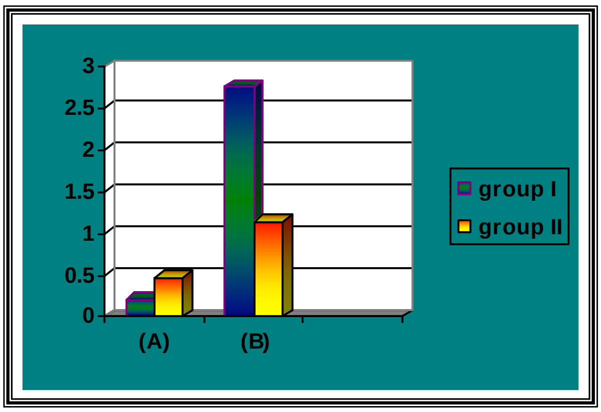

Fig. (1): Bar chart showing the differences in mean of

A-working length change in (mm)

B-spreader penetration depth in (mm)

Discussion

Canal shaping is a critical aspect of endodontic treatment because it influences the out come of the subsequent phases of canal irrigation and filling and the success of the treatment itself. Once the canal is prepared, it should have a uniformly tapered funnel shape, increasing in diameter from the end point to the orifice [(2)]. Recent advances in instrument designs and materials have resulted in the development of NiTi-rotary instrumentation for endodontic treatments of teeth. These NiTi endodontic instruments may reduce the difficulty of the instrumentation of curved canals compared with that of stainless steel files. Several systems have been produced with the aim of improving the canal shaping and to simplify and shorten the working sequences [(3)].

ProTaper files, one of the latest system, introduce the multiple taper concept, i.e., variable tapers in the same file are applied to specific areas of the canal, reducing the number of recapitulations necessary to arrive at the working length[(13)]. The mean preparation time noted in this study was least in ProTaper file group (288.66 sec.) Than K-flexo files (794.93 sec.) which involved fewer instruments change, compared with other group, furthermore the cross section of the ProTaper file which is a convex shape allow better cutting efficiency and more rapid root canal preparation, in the same time the non-cutting tip design ensure a non aggressive 'guiding" type of movement [(12,14)].

It's important in root canal therapy to control the working length to avoid over- and under extension. Controlling the working length during treatment maintain the apical constriction and allows effective obturation of the canal system. In the present study group I showed least change in working length than group II and the differences was a very high significant ($P<0.001$). As reported by Criffth et al. [(15)], the control of working length dose not appear to be a problem with NiTi rotary instruments the NiTi metal has a low bending moment, high spring back, and low stiffness contributing to its unique flexibility. Therefore rotary NiTi instrument seems to have more ability to preserve apical curvature than K-flexo hand instruments. Furthermore the shaping instruments of ProTaper file have a large coronal taper that improved initial cleaning and shaping, while the apical taper is smaller allowing penetration into apical curvatures. This results was concord with other reports [(16,17,18)]. Minimal decreases in working length also resulted in previous articles [(19,20)] but the authors of these studies doubted the clinical relevance of the findings. In group I spreader penetration was greater than 1mm from working length. This may attributed to the fact that greater taper gutta-percha cone (F3) that used in group I closed approximate to the prepared canal walls, that a potential disadvantage results from the inability of a spreader to predictably penetrated to within 1 to 2 mm of the working length [(8,21)].

In conclusion: our study showed that ProTaper systems have the advantage of quick preparation of canals with fewer instruments and maintain the correct working length than K-flexo files. However, in the same time less spreader penetration was observed with ProTaper system. Further study should be done to evaluate the quality of obturation or seal obtained using this technique.

References

1- Cohen S, Burns RC, eds. Pathways of the pulp 8th ed St, Louis CV Mosby Co St Louis Misso 64146,2002.
2-Schilder H: Cleaning and shaping of the root canal. Dent Clin North Am 1974; 18:269-96.
3-Weine FS, Kelly RF, Lio PJ: The effect of preparation on original canal shape on the apical foramen shape J Endodon. 1975; 1:255-65.
4-Roan JB, Sabala CL, Duncanson MG. The balanced force concept for instrumentation of curved canals. J Endod 1985; 11: 203-11.
5- Glossen CR, Haller RH, Dove SB, Del Rio CE: A comparison of root canal preparation using NiTi hand, NiTi engine-driven, and K-Flex endodontic instruments. J Endod 1995; 21: 146-51.
6-Gambill JM, Alder M, Del Rio CE: Comparison of NiTi and stainless steel hand file instrumentation. J Endod1996; 22: 369-75.
7- Beratti E, Negro AR, Lendini M, Pasqualini : influence of manual preflaring and torque on the failure rate of ProTaper rotary instruments. J Endod2004; 30: 228-30.
8-Bal AS, Hicks L, Barnett F: Comparison of laterally condensed..06 and.02 tapered gutta-percha and sealer in vitro. J Endod 2001; 27: 786-88.
9- Schneider SW: Acomparison of canal preparation in straight and curved roots canal. Oral Surg 1971; 32:271-75
10-BuchananLS: The standardized- taper root canal preparation part-GT files selection and safe handpiece-driven file use. Int E ndod J 2001; 34:63-67.
11-PeterParashos, Ian Gordon, Harold H Messer: factors influencing defects of rotary NiTi endodontic instruments after clinical use. J Endod 2004; 30:722-25.
12-edental. Com (website), accessed September 9; 2005.
13-Veltri M, Mollo A, Pini PP, Ghelli LF: In vitro comparison of shaping abilities of ProTaper and GT rotary files. J Endod 2004; 30:163-66.
14-Gutmann JL: The ProTaper system: Key to contemporary goals in root canal treatment. Endodod J 2004; 24-28.
15-Griffths IT, Bryant ST, Dummer PMH: Canal shapes produced sequentially during instrumentation with Quantee LX rotary nickel-titanium instruments: astudy in simulated canals. Int Endod J 2000;33:346-54.
16-YosbimineY, Ono A, AKamine A: The shaping effects of three nickel-titanium rotary instruments in simulated canals. J Endod 2005; 31:373-75.
17-Kum Yon K, Spangberg L, Cha BY, Young J, Jong LS: Shaping ability of three profile rotary instrumentation techniques in simulated resin root canals. J Endod 2000; 26:719-23.
18-Rangel S, Bryant S, Dummer P: Shaping ability of Race rotary nickel-titanium instruments in simulated root canals. J Endod 2005; 31:460-63.
19-Schafer E, Lohman D: Efficiency of rotary nickel-titanium instruments compared with stainless steel hand K-Flexofile. Part 1: shaping ability in simulated canals.Int Endod J 2002; 35:505-13.
20-Thomson SA, Dummer PMH.: Shaping ability of Hero642 rotary nickel-titanium instruments in simulated root canals: part 2. Int Endod J 2000; 33:255-61.
21-Zmener O, Pameijer CH, Macri E: Evaluation of the apical seal in root canals prepared with a new rotary system and obturation with a methacrylate based endodontic sealer: An In vitro study. J Endod 2005; 31:392-95.