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EVALUATION OF SURFACE CHANGES IN PROTAPER UNIVERSAL ROTARY FILES AFTER SINGLE AND MULTIPLE USES IN SEMI CURVED CANALS WITH DIFFERENT IRRIGATING SOLUTIONS: A SEM ANALYSIS

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ABSTRACT

NiTi files fracture due to fatigue failure which occurs after mechanical degradation of files. ProTaper rotary instruments are claimed to generate lower torque values during the use. The corrosion on the surface of Protaper files as a result of chemical reactions of irrigants causes different defects and may lead early fracture. So the present study was undertaken to evaluate surface changes in ProTaper files after multiple uses in semi curved canals in conjugation with three different irrigants. ProTaper files were used to instrument extracted premolars and molars with three different irrigants. These files are then subjected to SEM analysis to evaluate different topographical defects. It was found to be that in NaOCl group 60% of the files did not show any defect after single use where as 85 % of the files show fracture and micro cracks after multiple canals in NaOCl group. In Chlorohexidine group 40% files did not show any defect after single use whereas all of the files show defect after multiple use with equal distribution of micro cracks, distortion and disruption of cutting edges. Similar distribution of defects has been seen with EDTA group.

Keywords: ProTaper Universal rotary files, single and multiple use, scanning electron microscope

Introduction

Most important step in root canal treatment is cleaning and shaping of the canals. With the introduction and innovations in nickel titanium (NiTi) rotary instrumentation, negotiation of a challenging root canal system becomes possible due to greater flexibility of these files.[1] Shaping of curved canals became more effective after the introduction of nickel–titanium (NiTi) endodontic instruments. With newer more flexible rotary file systems becoming available, we need to be cognizant of the amount of deformity that occurs with each file after canal preparation. NiTi files are subjected to various stresses during clinical use. Both the instrumentation technique and instrument design can influence the magnitude of stress concentration and likelihood of instrument fracture.[2] However, there is an increasing concern about instrument fracture, as evidenced by the amount of reports on this problem. Separation rates of rotary NiTi instruments is approximately 1.0% with a range of 0.4%–3.7%,which is higher than stainless steel instruments.[3,4] Many studies have been done to find the reasons for fracture of NiTi rotary instruments after clinical use or in simulated canals. Fatigue fracture is caused by crack initiation at the surface and transgranular crack growth, which are likely to occur when the instrument is rotating within a curvature. [5,6,7] It is a common experience between clinicians that Ni–Ti rotary instruments may undergo unexpected fracture without any visible warning, such as any previous permanent defect

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or deformation.[8,9] Instrument fracture and separation was mainly found due to fatigue failure which occurs after mechanical degradation of files.[8,10]Recently, ProTaper Ni-Ti instruments (Dentsply Maillefer, Ballaigues, Switzerland) were introduced which have variable taper with modified nonradial landed cross-section that increases the cutting efficiency and reduces contact areas. ProTaper rotary instruments are claimed to generate lower torque values during the use.[11]The basic series of ProTaper comprises of three shaping instruments (Sx, S1, S2) for coronal and mid-root preparation, and three finishing instruments (F1, F2, F3) to prepare the apical area. Root canal system of the tooth usually has curved canals. To prepare a curved canal, the instruments with a low modulus of elasticity are required thereby maintaining the original canal curvature and less chances of fracture at curvature.[12] Some of the previous studies have shown the influence of cleaning and shaping root canals on NiTi rotary files. Other studies have evaluated the wear of rotary NiTi files under a variety of clinical and laboratory conditions. But no studies have assessed the impact of the repeated use of ProTaper files to simulate multi-rooted teeth. Various solutions can be used for root canal irrigation in endodontic practice. The corrosion on the surface of root canal instruments which occurs as a result of chemical reactions of irrigants causes irregularities and may lead early fracture.[13] The effect of various irrigating solutions on smear layer, dentinal surface and various obturation materials have been elucidated in various studies., but there are very limited research articles on effect of these irrigants on surface of NiTi rotary files. The solutions selected in the present study are sodium hypochlorite, chlorohexidine and EDTA solutions as they are popular and commonly used during root canal preparation. Surface morphology of NiTi files has usually been investigated with SEM. Most studies have examined ProFile or GT instruments. However, these studies have been usually carried out on simulated canals or non-standardized root canals of teeth. There are very limited studies to examine the file surface to identify the mode or mechanism of fracture. So the present study was undertaken to evaluate surface changes in ProTaper files after multiple uses in semi curved canals in conjugation with three different irrigants.

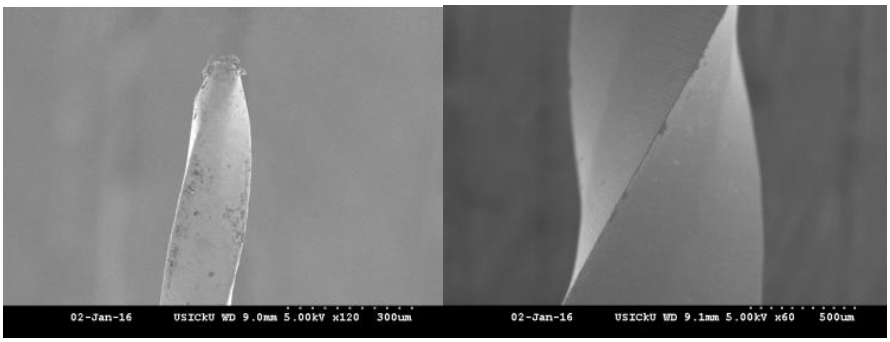
Materials and methodology

A total of twenty four mandibular premolars and forty two human mandibular molars teeth with 50^{o} canals determined by Shneider canal curvature system. Each root was radiographed to evaluate the shape of the root canal canal curvature. Teeth with open apex, developmental defects, teeth which had received restorative or endodontic therapy, abnormalities in root canal shape, resorption or calcified canals were excluded from selection sample. All canals were treated by a single operator. For each canal, the working length (WL) was estimated at the level of the apical foramen using a #10 hand K-file (Dentsply-Maillefer, Ballaigues, Switzerland), and a glide path was established using ProGlider (Dentsply-Maillefer, Ballaigues, Switzerland). Cleaning and shaping was carried out using the Protaper rotary file system (DENTSPLY, Maillefer, Ballaigues, Switzerland) driven by the X-Smart electric motor (DENTSPLY, Maillefer, Ballaigues, Switzerland) recommended torque and speed for each file according to manufacturer instructions. The ProTaper Universal System consists of three shaping files (ie, SX, S1, and S2) and three finishing files (ie, F1, F2, and F3). First, a gliding path was created using a #10 hand file to the working length. Second, an SX file was fed into the canal with a brushing outstroke motion for two thirds of its blade length. Third, a #15 hand file was passively used to reach the working length. The canals were then flared with the S1 and S2 files and the root canal was instrumented upto F2 finishing size file. Four sets of ProTaper assorted files were used to prepare single canal in premolars and other four set of files were used to prepare six canals in two molars each whose pulp chamber were filled with 5 % NaOCl throughout instrumentation, before S2 and F2 files of each set were examined by SEM. The other four sets of instruments files were used to prepare single canal of premolars and other four set of files were used to prepare six canals of molars each irrigated with 2% chlorohexidine. Similarly eight premolars and sixteen molars irrigated with 17% EDTA solution were cleaned and shaped with ProTaper files with four sets in one canal only

and four sets in five canals each. The root canal preparation was completed with an F2, after the canal was negotiated to the working length with a stainless steel #15K file, the F2 was used in the canal with an extremely light apical pressure until resistance was encountered. The instrument was then pulled out of the canal, cleaned with gauze and by ultrasonic cleaner to remove the debris filling the flutes. After the canal preparation, S2 and F2 files were examined by SEM, for visible defects (eg, unwinding and reverse winding with or without the tightening of the spirals) and indiscernible micro cracks.

Examination criteria

The criteria used for checking the instruments' surface defects were adopted by Eggert et al.[14] and were as follows: No visible defects, micro cracks, fractures, metal strips, spiral distortion, blunt or disruption of cutting edges. Three views of each file were chosen: apical, middle, and coronal areas.



Statistical analysis

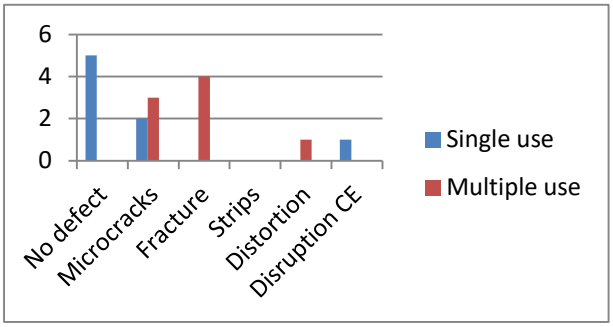
Statistical analysis of data was done with one way ANOVA with intra group comparison between three different groups.

Results

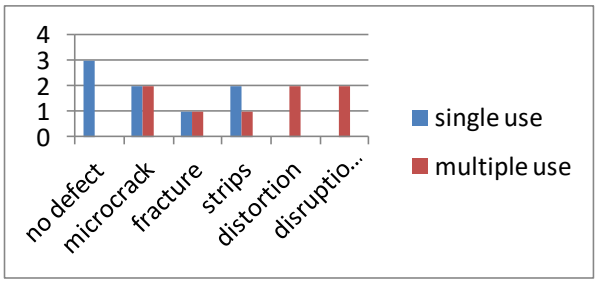
Analysis of the SEM images revealed that irrespective of irrigating solution used almost half of the files did not show any defect after single use for shaping semi curved canals where as almost all files in different irrigating solutions show different kinds of defects after multiple uses. The representative images of defects shown by SEM are shown in Fig 1 and the incidence of different defects are shown in Table 1.In NaOCl group 60% of the files did not show any defect after single use where as 85 % of the files show fracture and micro cracks after multiple canals in NaOCl group. In Chlorohexidine group 40% files did not show any defect after single use whereas all of the files show defect after multiple use with equal distribution of micro cracks, distortion and disruption of cutting edges. Similar distribution of defects has been seen with EDTA group. The intra group comparison of results of our study have shown statistically significant differences with in all three groups. The incidence of different kinds of defects in all three groups was found to be statistically insignificant. The comparison of these results are shown in graph 1,2 and 3 for three different irrigants after single and multiple uses.

Table 1: Incidence of different defects

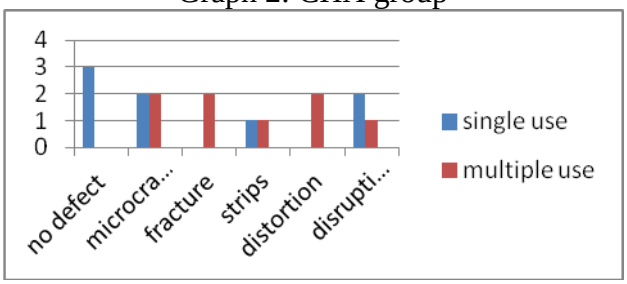
Criteria	5% NaOCl after single use	5% NaOCl after multiple uses	2% chlorohexidine after single use	2% chlorohexidine after multiple uses	17% EDTA after single use	17% EDTA after multiple uses
No visible defect	5		3		3	
Micro cracks	2	3	2	2	2	2
Fracture		4	1	1		2
Metal strips				1	1	1
Spiral distortion		1	2	2		2
Blunt or Disruption cutting edges	1			2	2	1



Graph 1: NaOCl group



Graph 2: CHX group



Graph 3: EDTA group

Discussion

Despite the increased strength and flexibility of NiTi instruments, a major concern with use of nickel-titanium instruments is fracture. The clinical concern is that they are reported to undergo unexpected fracture without warning.[15]Evaluation of cutting surface of rotary files after different uses in various irrigating solutions is of clinical relevance as this will help in the selection and application of NiTi rotary instruments during root canal treatment. ProTaper Universal rotary files with different irrigating solutions were chosen because of their frequent and widespread use. In our study we have used the ProTaper S2 and F2 because it has been shown to possess lower resistance to fracture because of cyclic fatigue than the other instruments in the ProTaper series.[15,8]Many studies have considered the effects of NaOCl on NiTi alloys but the effect of chlorohexidine and EDTA has not been elucidated fully. In the current study SEM images were analysed for evaluation of different topographical defects of files because SEM offers high-resolution images and allows characterization of the topographic features that appear on the file surfaces and the fractured surfaces without affecting the physical properties of files.[16,17,18] The SEM magnification levels that we chose to use had been used in several studies.[16,17,19]The results of the present study indicate that the incidence of different defects on rotary files were significantly greater after multiple uses than after single use. The results also reveal that micro cracks were present in almost all files irrespective of single or multiple uses in all three irrigating solutions. Results of our present research show that there occurs reduction in the fatigue life of NiTi rotary instruments after repeated usage due to accumulation of different defects, these results are consistent with those achieved by Patino et al and Vieira et al.[20,21]

Conclusion

Although ProTaper files are widely used in multiple canals and patients, clinicians should when preparing curved root canals with the same file that have already been used to shape

narrow root canals. It is recommended that corrosive effect of hypochlorite should be taken into account when using these files multiple times.

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