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Evaluation of the Instrument Life of A Rotary Nickel Titanium File in Curved Root Canals – An in-Vitro Study

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ABSTRACT

The aim of the present study was to evaluate the instrument life of a rotary Nickel Titanium file in curved root canals. Methods: 100 canals each from 50 extracted maxillary and mandibular molars were selected for measuring the mean number of uses. Each canal was prepared with continuous motion using an endodontic rotary hand piece using a single Protaper® F3 file until it reached the working length. One file was used until it was fractured or deformed. All the root canals were prepared by a single operator. Results: A total of 11 files were used in the preparation of 100 curved root canals. The average lifespan of one F3 file was 8.15±2.95 canals with the longest life span of 11 canals. Conclusion: Within the `limitations of this study one F3 file can be safely used to the working length of curved canals at least seven times under continuous motion.

KEYWORDS : Curved root canal, file fracture, lifespan, NiTi rotary files

Introduction

Louis Grossman once reported that a dentist who has not separated a tip of a file, reamer, or broach has not done enough root canals. [1] Any instrument used for shaping the root canal carries the risk of separation within the canal which should not be overlooked. These instruments include broaches, Gates Glidden burs, endodontic files, spreaders and lentulo spirals and can be made up of stainless steel, Nickel-Titanium and carbon steel. Fracture most often occurs following incorrect or excessive usage of the instrument and most frequently at the apical third of the root canal especially the molars due to the curvatures present.[2] To compensate for the disadvantages of the stainless steel instruments such as inflexibility, procedural errors like canal transportation, loss of working length, etc. the nickel titanium instruments were introduced into the market. These files have the property of superelasticity, aid in instrumentation of curved canals, minimize transportation and have superior resistance to torsional fracture than their stainless steel counterparts. Unfortunately, there has been rise in the advent of instrument separation of these instruments without prior warning even if the instrument is being used for the first time.[3]

The difficulty in retrieval of broken instruments from the canal is of serious concern because of its effect on the prognosis of the tooth. So the present endeavor was undertaken to determine the instrument life of a rotary nickel titanium file when used in continuous motion in curved root canals.

Materials and Methods

Preparation of the tooth sample

Fifty maxillary and mandibular molar teeth were used in this study. The curvature of each canal was measured using the method described by Schneider and the canals with the curvature of 20 to 45 degree were used in this study. Access cavities were prepared with a round carbide bur and the Endo-Z bur (Denstply) and the working length was determined by inserting a #10 K-file into the root canal until the tip of the file was flush with the apical foramen. From that point, 1 mm was subtracted, and that length was defined as the working length of the root canal, following which a glide path was produced using a #15 K-file.

Mean number of uses in continuous motion

Each canal from the selected teeth was prepared with continuous motion using an endodontic rotary hand piece. A single Protaper® F3 file was used to prepare the canal until it reached the working length. One file was used until it was fractured or deformed, after which it was replaced by a new file. EDTA (RC Prep, Premier Dental Products, Norristown, PA) was used in all canal preparations, and canal irrigation was performed with 3% NaOCl. All the root canals were prepared by a single operator.

Results

A total of 13 F3 files were used to prepare 100 root canals. The average life span of one F3 file was 8.15±2.95 canals. The longest lifespan of a single F3 file was 11 canals and the shortest was 7 canals.

Discussion

The separation of an endodontic instrument can transform any case from a simple to a complex one with an added iatrogenic factor to an already anatomically variant tooth/canal. With the introduction of nickel titanium rotary files the shaping of the root canals has improved tremendously but it disrupts the peace of mind of the operator once it separates.[4] There are 10 to 18 variations of nickel titanium rotary systems available in the market but no sure shot technique for removal once separated. Prevention is therefore much better rather than removal of the broken files.[5]

During root canal preparation a series of files are used to efficiently enlarge the canals before the next instrument could be used. Certain files bear more stress during preparation than the others so it is not possible to determine the number of times a file can safely be used before it can be discarded.[6] There are very few studies in the literature regarding the fracture incidence of a particular file. So this study was undertaken to determine the lifespan of a single master apical file size that goes to the working length in curved canals before it can be safely discarded.

The results of this study indicated that the average life span of a single Protaper F3 file in continuous motion was 8.15±2.95 canals. In a similar study reported by Sung-Yeop You et al. the data showed that the longest lifespan of single ProTaper F2 file with reciprocating motion was 21 canals with a mean lifespan of 10.60 canals.[3, 7] In this study the maximum number of times the Protaper F3 file could be used before fracture was 11 canals and the minimum number of times it can be used was 7 canals in continuous motion. According to Varela-Patino et al. the lifespan of the ProTaper files was found to be 10 canals when they were used in sequence under continuous rotation, whereas these ProTaper files could be used in up to 13 canals without fracture when reciprocating motion was employed.[8] As no coronal flaring was performed with shaping series of ProTaper files in this study, the results cannot be directly compared. But, as the same lifespan was obtained without any help of other sequential files, the results of this study appear to be extremely favorable in this regard.[3, 9] In a study by Sung-Yeop You, only 11 F2 files were used to prepare 120 canals, and this was a big reduction in the number of files necessary to instrument to the working length. Furthermore, it contradicts the notion in the clinician's mind that when using only one master apical size rotary file for the preparation of the entire root canal system, the stress exerted on this NiTI file should easily fracture it. But this can be explained by the reason that the file used in this study was a ProTaper file. ProTaper files are known to resist torsional fracture by uniformly distributing the stress exerted on it. However, further research is needed to evaluate not only the stress distribution in other types of files under continuous motion but also the cleaning and shaping ability of a single file with continuous motion.[3, 10]

According to a report by Sattapan et al, fracture of NiTi files occurs in one of two ways: flexural and torsional failure. Flexural fracture occurs

because of repeated compression and tension in curved canal. Torsional fracture occurs when binding occurs at a part of the file other than the tip. In the clinical situation, both torsional stress and cyclic fatigue are exerted on files within the root canal, and these two forces influence each other. NiTi files exposed to torsional stress are prone to fracture at a lower cyclic fatigue, and torsional resistance decreases in used files.[3, 11]

Recommendations to reduce the torsional fracture of NiTi files – [2, 3]

- Ullmann and Peters reported that larger instruments that have been subjected to some cyclic fatigue should be used with great care or discarded as the cyclic fatigue value and the torsional resistance value are inversely proportional.
- Preflaring and the crown-down preparation of the canal
- Instrument motion should be a light touch, rushing through a procedure should be avoided
- Use of an endodontic hand piece with reciprocating motion which prevents the taper lock phenomenon by unsymmetrical repeating of the clockwise and counter clockwise motion.
- Assess root canal curvatures radiographically and instrument them carefully.
- Ensure that the endodontic access preparation is adequate.
- Enlarge root canals with fine hand instruments
- Set rotational speed and torque at low levels.
- Irrigate and lubricate root canals during preparation.

In conclusion, within the limitations of this study, we can say that one ProTaper F3 file can be safely used 8 times in continuous motion in curved canals without separation or fracture within the root canal and without the help of other ProTaper files such as SX, S1, S2, F1 and F2.

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