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Lifespan of One Shape Files used in Severely Curved Canals in Resin Blocks and Extracted Teeth

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Abstract: ***The investigation traced the lifespan of One Shape files used in severely curved canals of resin blocks and extracted teeth. One hundred canals were shaped and all instruments worked till their fracture. The average lifespan in the group of artificial canals was 4.63±1.30 canals and of extracted teeth - 8.40±1.34 canals. The cumulative survival of tested files in both groups revealed significant difference. One Shape files manifested a lifespan similar to that of other NiTi systems with continuous rotation. Experimental protocols and obtained results should be interpreted very carefully, always having in mind the origin of the treated medium.***

Keywords: continuous rotation, cumulative survival, lifespan, One Shape, severely curved canals

1. Introduction

The successful root canal treatment is highly dependent on thorough removal of pulp tissue and cleaning of root canals (1, 2). At the same time, sufficient chemical disinfection of the entire canal system can be accomplished only after efficient shaping of the endodontic space (1, 3). Trying to give dental practitioners and endodontists the best device for root canal instrumentation, significant improvements and immense efforts have been made in the manufacturing of new engine-driven NiTi systems (4, 5).

Most of the systems consist of multiple instruments used for canal preparation in a sequential manner. A tendency of improving the design, flexibility and efficiency of NiTi files has been ongoing over the last decade. As a result of the attempt of simplifying the root canal instrumentation, different concepts of single file instrumentation systems have been invented (4, 6, 7). Some of them follow the reciprocating concept (8-10) but others are successfully and safely used in continuous rotation.

Nowadays, the engine-driven NiTi instruments in continuous rotation are widely accepted. One Shape is a single file system used in a continuous clockwise rotation. The system consists of one sterile file with a tip size ISO 25 and 6% constant taper. It has a variable pitch and a non-cutting safety tip. The instrument incorporates a variety of different cross-sections along the blade. Three different cross-section zones can be distinguished: the tip zone represents a variable 3-cutting-edge design; the second is a mixed zone and has a cross-section that progressively changes from 3 to 2 cutting edges and the coronal zone is provided with 2 cutting edges. Anti Breakage Control (ABC) system increases safety and avoids separation by unwinding of the instrument. The file is made of a conventional NiTi alloy but its cutting efficiency is enhanced by electropolishing. The system doesn't need a special endodontic motor to be driven.

During preparation, especially of curved canals, the instruments are subjected to cycles of compressive and tensile stresses as a result of repeated bending in the curvature (11-14). The stresses accumulate with extended use, leading to torsional and flexural fatigue, weakening of the instrument and its unexpected fracture.

When multiple instruments are used in a sequential manner with continuous rotation, the stress on each subsequent file is reduced. In single file techniques the stress on the instrument is expected to be higher than the stress on the files from the full-sequence rotary systems.

It is well known in literature (15-19), that preliminary creation of a glide path reduces the stress on the instrument, the fracture incidence and the possibility for its binding into dentinal walls. With the help of fine hand instruments or rotary NiTi files the shaping instruments can be used later safely and more effectively.

Many in vitro studies investigate the resistance of NiTi rotary files. Sometimes, their results are contradictory because experiments are held either on resin blocks or on extracted teeth and the behaviour of the instruments might differ in different working medium (20, 21). The aim of this investigation was to study the lifespan of One Shape files used for shaping of severely curved canals with different origin – resin blocks or extracted teeth, after a glide path creation.

2. Materials and Methods

The One Shape files (Micro Mega) were used for the preparation of 100 canals: 50 Endo-Training Block simulators (Dentsply Maillefer) and 50 canals of freshly extracted molars, after an initial creation of a glide path. The artificial canals had a 0.02 taper, an apical diameter of 0.15, a 65 degree curvature and a 7.5 mm curvature radius. Only the mesial canals of mandibular molars and the buccal canals of maxillary molars with preserved apical foramen and curvature more than 30º were shaped.

The angle and radii of canals curvature were determined by a radiographic image. The teeth selected were intact, without advanced attrition, abrasion, erosion or crown fracture. Each tooth crown was sectioned before the instrumentation, so that 3 mm of the crown walls above the cemento-enamel junction were preserved. The teeth were kept in a solution of 5.25% NaOCl for 30 minutes after the extraction and later they were immersed in a physiological (salt) solution.

Initially, all canals were scouted to full working length with a #10 hand K-file. G-Files (Micro Mega) were used for the glide path creation. The system consists of two instruments 21-25-29 mm long, with 0.03 taper size of the tip ISO 12 and 17 and variable cross-section throughout the length of the instrument. The 3 cutting edges are on three different radiuses relative to the axis of the canal, leaving a large and efficient area for upward debris removal.

The shaping was finished with the One Shape files. Following the instructions of the producer the files were operated using The WaveOne™ Endodontic system (Dentsply Maillefer). The One Shape files worked with continuous rotation (rotation speed – 400 rpm, torque - 2.0 gr/cm2). The G-Files were used with rotation speed of 300 rpm and torque - 0.6 gr/cm2. The amount of pressure applied to all files was the pressure that could be applied to a sharp #2 pencil without breaking the lead. The files were never forced into the canal.

During mechanical instrumentation each file was coated with Glyde™ (Dentsply Maillefer) to act as a lubricant, and a copious irrigation with 5.25% NaOCl was carried out. One Shape files worked till fracture occurred. The instrumentation of all canals was performed by a single operator. Average lifespan and cumulative survival at the time of One Shape files were tested.

Statistical analysis

The distributions of continuous variables are expressed as means ± standard errors. The performed comparative analysis of lifespan of instruments was based on the number of uses of each file before withdrawal because of fracture. The log-rank test was used to compare lifespan between different groups of files. The Kaplan-Meier method was used for the construction of survival curves.

3. Results

The One Shape files worked in relatively similar conditions during shaping the canals of extracted teeth and Endo-Training Blocks simulators. In both groups the canals were with a curvature more than 30º. The mean value of the curvature angle in the group of the extracted teeth was 42.32º (±17.29).

Average lifespan of One Shape files

Fifteen shaping files were used after a glide path creation – 9 during the instrumentation of the artificial canals and 6 – in the canals of the extracted teeth. Thirteen of them broke during shaping – 8 in the group of the artificial canals and 5 in the second group. The longest lifespan of a single file from the first group was 6 canals and from the second one - 10 canals. The shortest lifespan measured in the group of the artificial canals was 2 canals and in the other one - 7 canals. (Table 1)

After the creation of a glide path, the average lifespan of a single One Shape file used in artificial canals was 4.63±1.30 canals and it increased twice (8.40±1.34 canals) when canals of extracted teeth were shaped.

Table 1: The usage number of One Shape files used in different working medium

Files number	Working medium	Number of uses, including the separation
	Artificial canals	
1		3
2		6
3		6
4		6
5		5
6		5
7		7
8		7
9		*
	Extracted teeth	
1		11
2		10
3		8
4		10
5		8
6		*

* The last files used for the preparation of the canals in each group which didn't separate.

Cumulative survival at the time of One Shape files

The cumulative survival of One Shape files used for shaping of canals with different working medium reveals significant difference (p=0.001). Figure 1 shows the survival curves of the instruments in both groups, using the log-rank test. (Fig 1).

The difference in the files' survival is clearly distinguished when a comparison between the two groups is made. At the shaping of the 7th canal all One Shape files were broken in the group of the artificial canals, while all files remained safe in the group of the extracted teeth.

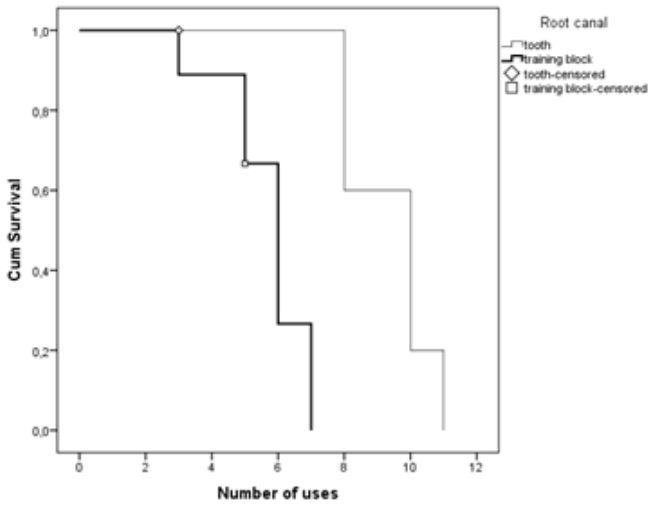

Figure 1: Survival curves of One Shape files used in different working medium

4. Discussion

There are no many studies available on the lifespan and fracture resistance of One Shape files (7, 21). The manufacturers of the system claim it should be used for one tooth only or for a maximum of three or four canals in one tooth. Although it is not advisable to sterilize the One Shape files, because the cutting efficiency decreases severely, sometimes dental practitioners use them repeatedly and thus increase the chance of their unexpected fracture. This made us study in vitro the survival of One Shape files, especially during shaping of severely curved root canals.

On the other hand, the main purpose of this study was not only to investigate the lifespan of One Shape files but to compare the results obtained during shaping of canals with different origin – resin blocks and extracted teeth. We wanted to trace the influence of the different working medium on the survival of the tested instruments.

One Shape files were used for shaping of equal number of canals in resin blocks and extracted teeth. They worked in relatively similar conditions because all shaped canals were with a canal curvature more than 30º. The curvature angle of the canals in the resin blocks was 65º and the mean value of the curvature angle of the canals in the extracted teeth was 42.32º (±17.29).

Following strictly the producer's instructions, a glide path was created before final shaping of canals. In our investigation we used G-Files which are also a product of Micro Mega and have a tip size of 12 and 17, respectively.

The results of average lifespan of One Shape files used in artificial canals (4.63±1.30 canals) are not so high and are closer to the recommendations of the producer. The lifespan increases twice in the group of the extracted teeth and is relative to the results achieved in other investigations of files with continuous rotation (16, 22, 23). Although NiTi instruments are highly appreciated for their elasticity and flexibility (24-27), the results from our study are not surprising, because we intentionally chose canals with great curvature angle. It is well documented (28-32) that stresses on the instruments increase considerably when they are used in canals with severe curvatures. We tried to reduce instrument fatigue and stress with a preliminary creation of a glide path. After the second G-File (ISO 17) we prepared a canal with apical size still much smaller than the tip size of the One Shape file (ISO 25). The repeated use of the shaping files multiplied the effects of the severe curvature and resulted in the low number of successful uses, especially in artificial canals (2 canals).

To some extent, our results can be explained with the continuous mode of rotation of the One Shape file, as well. In the last decade, new systems with reciprocating rotation with equal or unequal angles of rotation were introduced. These systems had proved their superiority (11, 12, 19, 22, 33-36), regarding safety and number of successful uses. The continuous mode of rotation increases the probability of binding the instrument tip into dentinal walls, exceeding the elastic limit of the metal composing the instrument and increasing the risk of fracture.

The cumulative survival of One Shape files used in canals with different origin (resin blocks and extracted teeth) reveals significant difference. The results achieved in the second group are much better than the registered in the group of the artificial canals. On one hand, they can be due to the difference in the curvature angle of the canals in the two examined groups - 65º of artificial canals and average value of 43º of extracted teeth. On the other hand, the shaped canal walls were of different origin – resin or dentin. We assume that dentin elasticity has significant effect on behavior and resistance of shaping files and that's why treated medium and investigation results should be considered very carefully during discussion of experimental protocols. This opinion is supported by other investigators, as well (7, 20, 37).

The results of this study revealed that One Shape files have a lifespan similar to that of other NiTi systems with continuous rotation. Design of experimental protocols and obtained results should be interpreted very carefully, always having in mind the origin of the treated medium.

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