# LIFESPAN OF NITI ROTARY FILES WITH 360° ROTATION AND RECIPROCATING MOTION

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## ABSTRACT

***Objective:*** *To assess the life of two different rotary nickel-titanium (NiTi) instruments in curved canals with complete protocol, by using 360° rotation motion and reciprocating motion.*

***Materials and Methods:*** *About one hundred and seventy extracted maxillary and mandibular molars were taken from which two hundred curved root canals were selected and randomly divided in 2 groups, for analyzing the number of uses of rotary files. One hundred curved canals were prepared with Hyflex EDM 25/~ (coltene) in 360° continuous motion and one hundred canals were prepared with Reciproc R25 (VDW) in reciprocating motion to full working length. One file was used to prepare root canals until fractured. Every file used was coated with 17% EDTA and copious irrigation with 2.5% NaOCl was done. t-test was used to analyze data.*

***Results:*** *A total of 7 Hyflex EDM 25/~ and 10 Reciproc R25 files were used to prepare 200 curved root canals, 100 with each file. The average life of one Hyflex EDM 25/~ file was 13±1.50 canals and of Reciproc R25 was 9±1.59 canals. Among Hyflex EDM one file prepared maximum number of 15 canals and among Reciproc maximum canals prepared by one file were 13. There was a statistically significant difference between the two groups ($p < 0.001$).*

***Conclusion:*** *Hyflex EDM25/~ and Reciproc R25 can safely prepare 13 and 9 canals respectively to full working length if complete protocol is followed.*

***Keywords:*** *Curved root canal, lifespan, nickel-titanium file, 360° rotation, reciprocating motion*

## INTRODUCTION

Nickel–Titanium alloy exists in various crystal forms and has three microstructural phases (austenite, R-phase and martensite) on which the mechanical properties of the metal depend[1]. Lifespan of file depends on operator skill, heat treatment of file metal, type of metal and type of motion of file used.In Pakistan now a days, specialists and general dentists are commonly using Nickel-titanium (NiTi) rotary files for root canal preparation. There is a risk of unexpected torsional and flexural fracture despite their shape memory and high flexibility[2,3,4]. Mostly torsional separations occur when handle of file keep on rotating but the tip or any other part of the file stuck to the canal walls. Flexural failure occurs when a file freely rotates inside curved root canal but has tension and compression on its surface at the point of flexure which make file weaker, and fracture occurs at the point of maximum flexure[5]. Broken file is difficult to remove when its small and apical to curvature of canal. Retrieval of broken file is usually impossible without compromising root dentin. In some cases, file retrieval becomes impossible and root resection becomes preferable treatment option[6].

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Some literature evidence supports canal negotiation, glide path creation and pre-flaring before using NiTi files to reduce risk of fracture[7].

Reciprocating motion was introduced in dentistry to improve the fracture resistance of rotary NiTi files and was claimed by manufacturers to extends the lifespan of a Nickel-Titanium instrument by reducing resistance inside canal when compared to continuous rotation motion[8]. Many reciprocating systems are available in the market out of which two are popular: Reciproc (VDW, Germany) and WaveOne (Dentsply), with specific endomotor with an un-changeable setting. The Reciproc rotary files are used with 300rpm speed and with 150º counterclockwise and 30º clockwise rotation. All reciprocating file systems have counterclockwise movement 3 to 5 times greater than clockwise movement. Reciproc R25 has tip size of 0.25mm (ISO 25 tip) and 8% taper over the first apical millimeters and it is used for narrow canals. Its design has been improved to increase flexibility[9].Another way of improving life of rotary file is by heat treatment which changes microstructural phase of rotary file and increases flexural fatigue resistance and torsional fracture resistance. NiTi has different temperature dependent morphologies. It exists in austenitic and martensitic crystalline from at high and low temperature, respectively. Austenitic state is centered cubic lattice and martensitic state is a monoclinic distorted structure which allows martensitic material to deform at greater angles. One modification NiTi is the M-Wire alloy which contains austenite, martensite and R-phase. It is produced by series of heat treatment and annealing cycles during drawing of wire to stabilize the crystalline structure of the NiTi in its more martensitic condition at body temperature. It was first introduced in 2007 by Dentsply Tulsa Dental. Alapati et al (Alapati, 2009)[10] analyzed that austenite finishing temperature (AF) of M-wire is around ($45^0$C to $50^0$C) as shown by TMDSC analysis[11].

Electric discharge machining (EDM) followed by heat treatment is one of the ways of improving cyclic fatigue and torsional fracture of NiTi files, it also increases fracture resistance by 700%[12]. Manufacturing of Hyflex EDM (Coltene, Whaledent) file is done by this process. EDM is a noncontact thermal erosion process used to machine electrically conductive materials using controlled electrical discharges. The electrical sparks prepare material surface by local melting and partially evaporation in small segments that are removed from this local area leaving a crater-like finished surface. Acid is used in ultrasonic bath for surface cleaning after preparation. Then before or after the cleaning process for 10 mins to 4 hours heat treatment is given at temperature between $300\text{-}600^0$. Austenitic finishing (Af) temperatures of EDM files is over 52°C. Non-directional surface finish of file is made by EDM process to avoid early material failure[13]. In Pakistan, commonly used NiTi rotary file systems are Hyflex EDM and Reciproc. This study will help to identify number of uses of a NiTi rotary files in specific motion. It will also help clinician to decide when to discard a file and prevent mishaps which will ultimately affect final treatment outcome.

## MATERIALS AND METHODS

### Tooth preparation

Pre-operative radiographs were taken to exclude any calcified canal or canal with broken instrument. All selected teeth were stored in sodium hypochloride for 5 days for disinfection. The mesio-buccal (MB) and disto-buccal (DB) canals of maxillary molars and the mesial canals of mandibular molars of 170 teeth were selected in this study. Method described by Schneider was used to measure curvature of roots[14], and the roots with curvatures of $20^0 – 50^0$ were used. The endodontics access cavities were made on all teeth with round diamond and Endo-Z burs. All root canals were negotiated and working length of each canal was taken using #10 K-file until tip of file was visible through the apical foramen with naked eye. Working length of each root was adjusted by reducing it 0.5mm from apical foramen. After adjusting working length teeth were mounted on plaster block. Then a #15 K-file was used to make glide path to full Working length.

### The Mean Number of Uses in Reciprocating Motion and Continuous rotation

In this study 100 canals from 95 extracted molars were selected for preparation with reciprocating motion (clockwise $50^0$ and counterclockwise $180^0$) using the E-connect S, Eighteeth endomotor (china) with Reciproc R25 and other 100 canals from 75 molars were prepared with Hyflex EDM/~25 until reached apical foramen. One file coated with 17% EDTA, was used until deformed or fractured, after

that it was replaced. All canals were irrigated with 2.5% NaOCl and were prepared by a single operator having experience of 10 years. The results were statistically analyzed using the t-test.

## RESULTS

### Mean Number of Uses with Reciprocating Motion and Continuous rotation

A single operator prepared all the root canals. Total of 07 Hyflex EDM/ ~25 files and 10 Reciproc R25 (Table. 1) files were used to prepare 200 curved root canals. For Hyflex EDM/~25 data of six files were used and for Reciproc R25 data of nine files was used to calculate life span. For Hyflex EDM/~25 and Reciproc R25, 7th and 10th files were not included in data as they were not fractured during root canal preparation. In this study all canals in which files were broken and number of uses of last file which were not broken were also excluded.

In this study the maximum number of uses for Hyflex EDM25/~ was 15 while the minimum usage was 11 respectively, while for Reciproc R25 the maximum usage was 13 and minimum was 7 (Table. 1). Mean number of uses for Hyflex EDM/~25 and Reciproc R25 was 13±1.5 and 9±1.59 respectively. There was statistically significant difference between the two groups (P<0.001) which was assessed using t-test (Table. 2).

Mean number of uses for Hyflex EDM/~25 and Reciproc R25 was 13±1.5 and 9±1.59 respectively. In this study longest and shortest lifespan of Hyflex EDM25/~ was 15 and 11 respectively. However, in Reciproc R25 longest and shortest lifespan was 13 and 07 respectively (Table. 1). There was statistically significant difference between the two groups (P<0.001) which was assessed using student t-test (Table. 2).

## DISCUSSION

For the cleaning and shaping of root canal system, many clinicians use one or more NiTi files in sequence or combination of files but when files are used in recommended sequence some files tolerate

**Table 1: Number of uses of each "Hyflex EDM 25/~ one file" in 360° rotation and number of uses of each "Reciproc R25" file in reciprocating motion in curved canals.**

| Sr. no. | Instruments | | Number of uses | |
|---|---|---|---|---|
| | Hyflex EDM 25/~ | Reciproc R25 | Hyflex EDM 25/~ | Reciproc R25 |
| 1 | 1 | 1 | 14 | 10 |
| 2 | 2 | 2 | 12 | 09 |
| 3 | 3 | 3 | 14 | 07 |
| 4 | 4 | 4 | 15 | 09 |
| 5 | 5 | 5 | 11 | 09 |
| 6 | 6 | 6 | 14 | 13 |
| 7 | 7 | 7 | 14* | 10 |
| 8 | | 8 | | 10 |
| 9 | | 9 | | 09 |
| 10 | | 10 | | 05* |
| Total | 7 files | 10 files | 94 | 91 |

**Table 2: Mean number of uses of rotary files**

| Mean number of uses | | | | p-value |
|---|---|---|---|---|
| Hyflex EDM 25/~ | | Reciproc R25 | | |
| Mean | SD | Mean | SD | <0.001 |
| 13.0 | 1.50 | 9.0 | 1.59 | |

more stress than others. So, it is impossible to measure the lifespan of a particular file reaching apical foramen. When a file becomes deformed or when the operator feels insecure about the state of the file, he discards it. So, there are very few reports on the fracture incidence of some brands of NiTi files.

This study was done to determine lifespan of single NiTi rotary file that goes to apical foramen. This study compares lifespan of Reciproc R25 reciprocating motion and Hyflex EDM~25 NiTi file with continuous rotation. They were selected because both are single-file system and are safe ended files with 0.25mm tip size. Both were used after making a glide path with #15 file. Presently all manufacturers recommend single use of file but because of cost of NiTi rotary files they are reused. Like any other NiTi file these files also break suddenly without giving any warning. According to a retrospective study most of NiTi files fractured in curved root canals of mandibular molars[15].

In the present study, we used natural teeth with canal curvature from 20° to 50°. Most of the NiTi files were fractured a few millimeters from the tip. This might be because of maximum flexure of file and greatest stress inside the curved canal but at the same few files fractured from middle portion. So main cause of file fracture is still uncertain and needs further research[16].

File can fracture because of flexural cyclic fatigue and torsional stress[17]. One possible way to reduce chance of flexural fatigue fracture by using file only once. To overcome torsional stress always consider making proper glide path, pre-flaring and crown down technique for root canal preparation. With glide path creation root canal diameter becomes wider than the tip of the first rotary instrument used, reducing the stress the instruments suffer. In crown down technique root canal is prepared in three portions coronal, middle and apical. This segmental preparation reduces stress on file by not letting it contact root canal throughout its length[18].

In this study we used crown down technique after pre-flaring of root canal which supposedly increased life of both rotary NiTi files. The average lifespan of one Reciproc R25 file was 9±1.159 canals and of one Hyflex EDM ~25 file was 13±1.50 canals. The difference was statistically significant ($p<0.001$). In the Reciproc group we found out nine broken files during the instrumentation of hundred canals and the longest lifespan in the observation was 13 canals and shortest was 07 canals. The longest lifespan observed in Hyflex EDM group was 14 canals and shortest was 11 canals. Results in our study were contradictory to results of another study in which they used resin blocks with curved canals and found out that reciprocating motion results in less NiTi file fracture than continuous rotation[19]. In their study the mean number of uses was 10 with reciprocating motion which is nearly similar to results of our study but mean uses with continuous rotation were 4-5. The stress concentration on rotary file during work in the root canal is inversely proportional to lifespan of instrument. Theoretically, chances of torsional fracture due to taper lock are reduced by the reciprocating motion[8].

This study revealed that 7th file of the Hyflex EDM was intact at the end of 100th root canal preparation while Reciproc system took 10 files to prepare 100 canals. The greater number of uses can be due to not only the creation of a glide path but also EDM technology of file manufacturing, file design and heat treatment. In conclusion, within the limitations of this study, the Hyflex EDM files showed significantly higher resistance to fracture compared with the Reciproc files. File manufacturing with EDM technology and heat treatment significantly increases instruments life and makes them safer during shaping of root canals.

## CONCLUSIONS

Hyflex EDM25/~ and Reciproc R25 can safely prepare 13 and 9 canals respectively to full working length if complete protocol is followed Canals in which files were broken were excluded from study.

* In Hyflex EDM 25/~ life span of 7th file and in Reciproc R25 life span of 10th file was not included in data analysis as these were not fractured during completion of 100th canals.

### Study limitations

The study has potential limitations like small sample size and uneven distribution of impacted molars in different categories. Further researchers are recommended to base the same study on a larger sample size and equal distribution of impacted molars in different categories to get more accurate results.

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