

Rainbow Files polishing technology: a cyclic fatigue study

FINAL REPORT



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Cyclic fatigue

Background

In clinics, cyclic flexural fatigue of an instrument occurs when it rotates in a curved canal by repeated cycles of compressive and tensile stresses. Cyclic fatigue parameter represents mechanical resistance measures, whose improvements anticipate a better clinical performance when submitted to that specific stress reducing the chance of instrument fracture.

Aim

To evaluate the cyclic fatigue of RCS Rainbow One 25/0.06 (Ramo Medical, China) with traditional polishing technology compared to the same instrument but with an upgraded polishing technology.

Sampling

Based on the results of previous studies (1-4), a power calculation was performed using G*Power 3.1 (Heinrich Heine University, Dusseldorf, Germany) software indicating a minimum sample size of 10 instruments per group for the test.

Methods

Before the mechanical testing, instruments were examined under a stereomicroscope to ensure that no defects that could lead to deformation were present.

Cyclic fatigue

Cyclic fatigue test were performed using a custom device that allows to simulate a instrument working passively in a curved canal, as previously described (1-6). Instruments followed the rotation motion recommended by the manufacturer (400 RPM and 2.0 N.cm). Instruments were mounted on a 6:1 reduction handpiece (VDW/Sirona Dental Systems, Bensheim, Germany) powered by an electric motor (Reciproc Silver; VDW GmbH, Munich, Germany) and assembled on a tube model custom-made device (**Figure 1**). The electric handpiece were mounted on a device to allow accurate and reproducible placement of each instrument within the simulated canal. The time to fracture (TTF) were recorded in seconds for each instrument using a digital chronometer and the experiment stop as soon as the fracture

were detected visually and/or audibly. A digital microcaliper were used to determine the length of each fractured fragment length (FL).

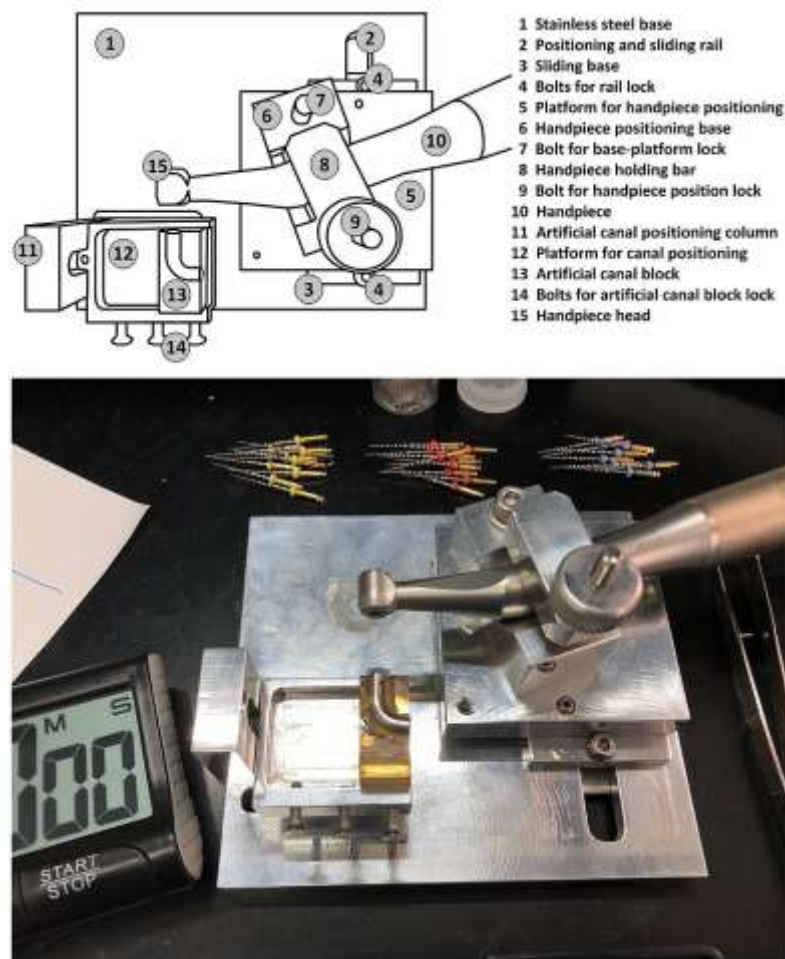


Figure 1. A custom-made device to perform cyclic fatigue resistance test.

Statistical analysis

The Shapiro-Wilk and Levene tests were used to evaluate the assumption of normality and the equality of variance of data sets. Considering that results were normally distributed ($p > .05$), they were presented as means and standard deviations and statistically compared between groups using independent sample t-test. Significance level was set at $p < .05$ (SPSS v18.0 for Windows; SPSS Inc, Chicago, IL, USA).

Results

Cyclic fatigue test

Raw and consolidated data, as well as, statistical analysis regarding the number of cycles to failure of RCS Rainbow One 25/0.06 with traditional polishing technology and RCS Rainbow One 25/0.06 with upgraded polishing technology are presented in **Table 1**. The upgraded polishing technology instruments showed a higher time to fracture and a higher number of cycles to fracture when compared to traditional polishing technology instruments ($p < 0.0001$). The mean and standard deviation of the time to fracture and number of cycles to failure are presented in **Table 2**.

Table 1. Time to fracture (in seconds) and number of cycles to failure of RCS Rainbow One 25/0.06 instruments with traditional or upgraded polishing technology subjected to cyclic fatigue test (raw data).

Upgraded polishing technology		Traditional polishing technology	
Time to fracture (in seconds)	Number of cycles to fracture	Time to fracture (in seconds)	Number of cycles to fracture
109	726.6	15	100
95	633.3	26	173.3
87	580	17	113.3
79	526.6	18	120
42	280	12	80
78	520	13	86.6
36	240	15	100
81	540	14	93.3
82	546.6	22	146.6
68	453.3	13	86.6

Table 2. Time to fracture (in seconds) and number of cycles to failure mean and standard deviation values

	Upgraded polishing technology	Traditional polishing technology
Time to fracture (in seconds)	75.7 ± 22.2	16.5 ± 4.4
Number of cycles to fracture	504.6 ± 148.4	110.0 ± 29.6

Remarks

According to the manufacturer RCS Rainbow 25/0.06 traditional and upgraded polishing technology instruments have exactly the same design regarding tip, taper, cross-sectional design and also the same manufacturing process and heat-treatment differing only in the polishing technology. The present results point to a clear advantage in terms of cyclic fatigue for the upgraded polishing technology instruments, with a statistically significant difference when compared to traditional polishing technology. Therefore, it is clear that the upgraded polishing technology improved the cyclic fatigue resistance and is recommended to be used in RCS Rainbow 25/0.06 instruments.

References

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