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Biomaterials Research Results

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*June, 2023*

# Laboratory Evaluation of FQ Rotary Endodontic Files

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## Introduction:

This study evaluated the cyclic fatigue resistance and cutting efficiency of 2 types of rotary endodontic files. SEM evaluation of files after fatigue failure, and cross-sectional design was also conducted.

**Materials:**

Size #15.03, 20.06, 25.06 files: ***FQ Rotary Files*** (Komet USA), Size #20.04, 20.07, 25.08 ***ProTaper Ultimate*** (Dentsply Sirona)

Endo Motor + Handpiece: ***Promark Endo Motor*** (Dentsply Sirona) and ***TUL-8M*** handpiece (Dentsply Sirona)

## Methods:

**Cyclic Fatigue Resistance (n=10):** 10 files of 3 different sizes were tested as received. Canals precision milled into hardened stainless steel with 5 mm radius and 80° angle in the DENTAL ADVISOR Cyclic Fatigue Platform was used at 400 RPM. Time until fracture was recorded, and means with standard deviations reported in the results. Representative images of files that failed after cyclic fatigue testing were imaged under SEM.

**Cutting Efficiency and Durability (n=5):** After practice and familiarization with the materials, canals were instrumented root canals of Endo-Training-Bloc (Ref: A0177, Dentsply Sirona) with light water irrigation to remove excess debris using a light pecking motion when resistance was felt. The working time to reach the apex was measured for each instrument in sequence and the sum of the working times for each file used was calculated for files listed in the materials section. Canals were first prepared using the 16.02 file for ***ProTaper Ultimate***, and 20.08 Opener for ***Komet FQ.*** Three canals were instrumented in sequence by each set of files at 400 RPM, and with torque limits set suggested by each manufacturer's instructions. Microscopic evaluation under 40x magnification next to new files were conducted before continuing to detect the presence of unwinding. Files were weighed before and after their first use to measure the amount of debris which was removed attached to the files with 5 replications each. Representative photographs were taken of the presence of debris.

| Product | Komet FQ | | | Dentsply ProTaper Ultimate | | |
|---|---|---|---|---|---|---|
| File Size | 15.03 | 20.06 | 25.06 | 20.04 | 20.07 | 25.08 |
| Cutting Time, s | 6.1 (0.4) | 8.6 (0.5) | 8.5 (0.5) | 10.9 (0.6) | 10.6 (0.6) | 8.3 (0.5) |
| Full Sequence Cutting Time, s | | 23.2 (0.6) | | | 29.8 (1.0) | |
| Debris Removal, mg | 0.46 (0.09) | 1.38 (0.23) | 2.10 (0.57) | 0.32 (0.08) | 0.78 (0.13) | 0.60 (0.12) |
| Cyclic Fatigue, s | 81 (10) | 141 (19) | 123 (10) | 74 (14) | 66 (11) | 54 (13) |
| Cyclic Fatigue, cycles | 543 (67) | 941 (129) | 823 (68) | 495 (92) | 440 (70) | 361 (88) |

**Cutting Efficiency and Durability Summary:** Overall cutting rate for ***FQ Rotary Files*** was 24% faster than ***ProTaper Ultimate***. All files survived past 3 canals. The canal opening file 20.08 allowed less resistance for the initial 15.03 file for ***FQ Rotary Files*** which may have contributed to the subsequent values. There was little resistance found with the 15.03 file until the apex as expected.

**Debris Removal**: ***FQ Rotary Files*** removed significantly more debris attached to the files. Longer strips of debris were generally created due to the grooves of the files compared to ***ProTaper Ultimate*** which tended to shred the canal into more fragments. The larger outside surface area of the ***FQ Rotary Files*** and larger lands also may contribute to higher measured debris removal.

**Cyclic Fatigue Resistance Summary:** ***FQ Rotary Files*** has between 110 % and 228% of the cyclic fatigue as ***ProTaper Ultimate***.

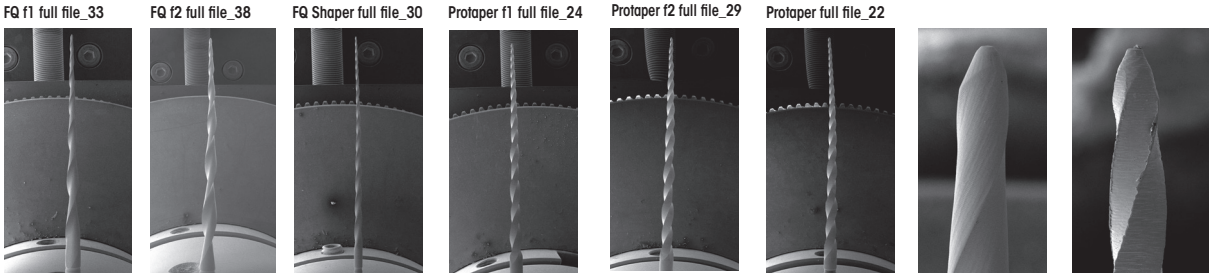



**Fig 1.** Full Length views of ***FQ Rotary Files*** and ***ProTaper Ultimate*** files.



**Fig 2.** Magnified views of tip design, ***FQ Rotary Files*** 20.06 and ***ProTaper Ultimate*** 20.07 files.

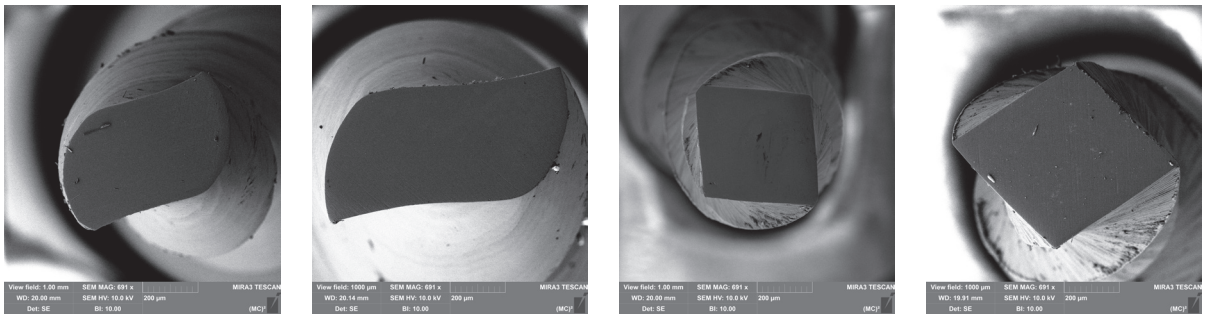


**Fig 3.** Cross-sectional views of 20.06 ***FQ Rotary Files*** and 20.07 ***ProTaper Ultimate*** rotary files sectioned at 8 mm and 13 mm from the tip. ***ProTaper Ultimate*** files feature a parallelogram design with a variable ~85-105° cutting edge. ***FQ Rotary Files*** feature a more acute cutting angle with a ~110-130° cutting edges with 2 smooth lands which function to reduce transportation, screw-in effect and aid in debris removal. ***FQ Rotary Files*** have a 0.23 and 0.35 $mm^2$ cross-sectional area and 0.7 mm and 1.0 mm diameter at 8 mm and 13 mm distance from the tip compared to 0.17 and 0.28 mm2 area and 0.6 and 0.8 mm diameter for the ***ProTaper Ultimate***.

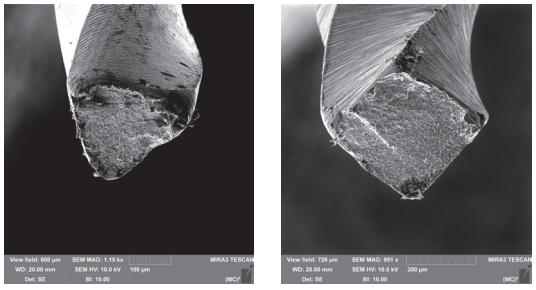
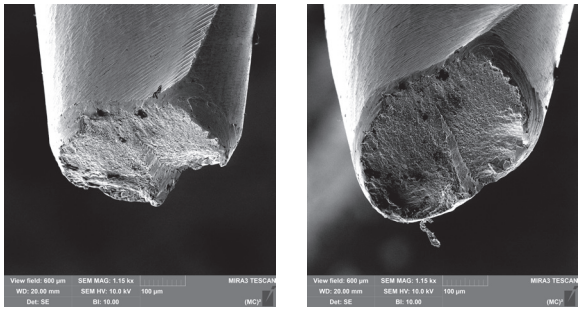


**Fig 4**. Size 15.03 and 20.04 files after cyclic failure



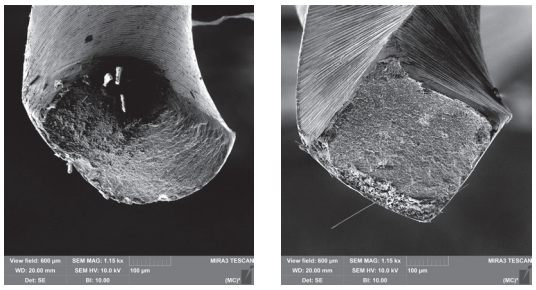


**Fig 5.** Size 20.06 and 20.07 files after cyclic failure

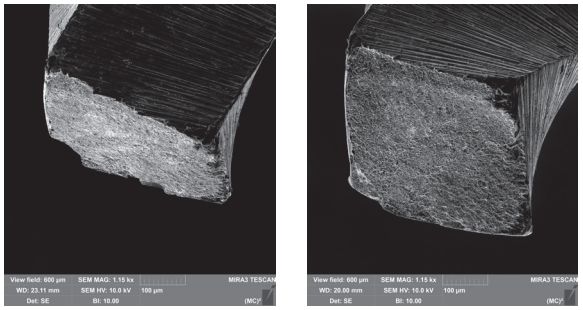


**Fig 6.** Size 25.06 and 25.08 files after cyclic failure.

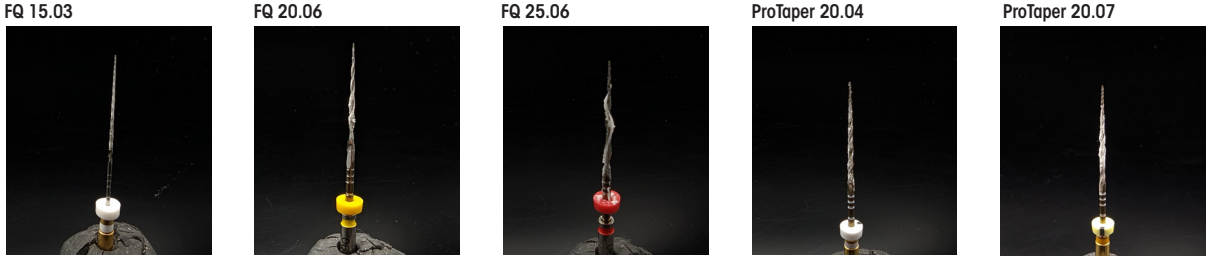



**Fig 7.** Images of debris removal after cutting evaluation. The amount of debris left on the file is variable with how much debris is removed from water irrigation in the simulated canal.