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Biomaterials Research Report

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Laboratory Evaluation of Procodile Q Endodontic Files

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Introduction:

This study evaluated the cyclic fatigue resistance and cutting efficiency of 2 types of reciprocating files, the new ***Procodile Q*** from Komet® and ***WaveOne Gold*** from Dentsply Sirona. The heat-treated ***Procodile Q*** features a variable tapered core for increased flexibility toward the shank while the cutting edges are uniformly tapered for a uniform canal excavation. The cutting edges feature a double S curve for improved evacuation of debris while cutting.

A ***Promark Endo Motor*** (Densply Sirona) was used with the ***WaveOne*** setting (170° CCW cutting, 50°CW motion) for tested file sizes 020, 025, 035. The cyclic fatigue test using the DENTAL ADVISOR Cyclic Fatigue Platform featuring a 80° and 5 mm radius was conducted until file failure. Cutting efficiency and durability was assessed using plastic blocs with canals instrumented in sequence with 3 canals per file, until unwinding or file damage occurred, with the time to instrument each canal measured.

Conclusion:

Procodile Q files lasted between 197 % and 325% longer in the cyclic fatigue test than ***WaveOne Gold. Procodile Q*** files also instrumented the training blocs about 16% faster overall with less file damage detected, and with more debris removed coronally.

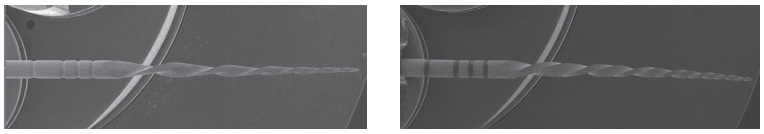


Fig 2. Full Length views of ***Procodile Q*** and ***Wave One Gold*** #025 primary files.

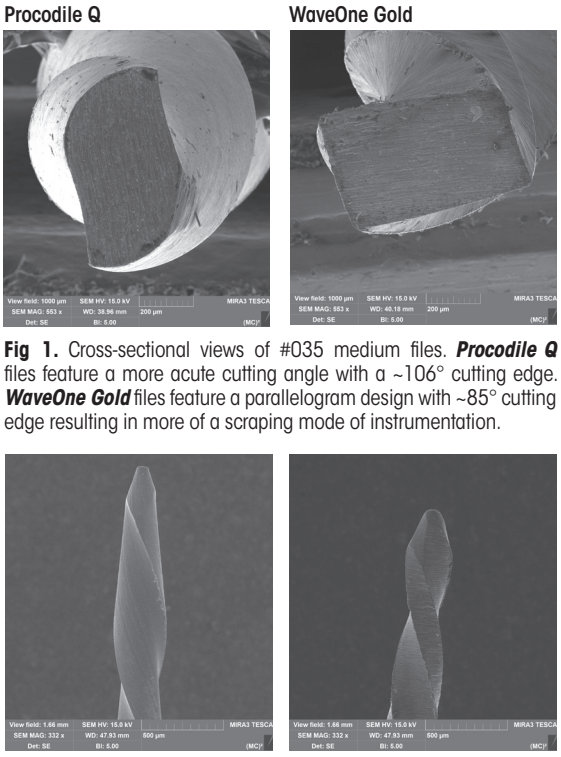
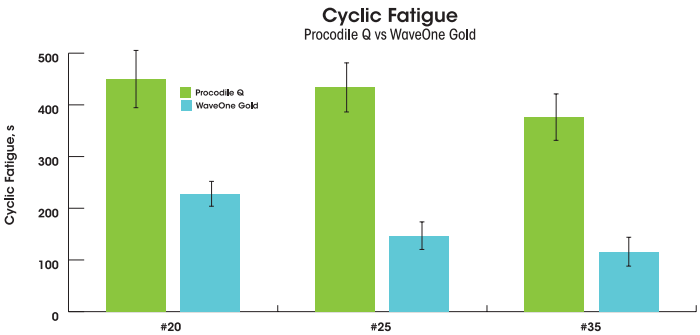


Fig 1. Cross-sectional views of #035 medium files. ***Procodile Q*** files feature a more acute cutting angle with a ~106° cutting edge. ***WaveOne Gold*** files feature a parallelogram design with ~85° cutting edge resulting in more of a scraping mode of instrumentation.

Fig 3. Magnified views of tip design

Tests:

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 using the ***WaveOne Gold*** setting for all files without irrigation. Time until fracture was recorded, and means with standard deviations reported in the results.



Cyclic Fatigue Resistance Summary: ***Procodile Q*** files lasted between 197 % and 325% longer in the cyclic fatigue test than ***WaveOne Gold.*** The combination of the heat treatment, lack of surface defects and variably tapered core likely contributes to higher cyclic fatigue resistance for ***Procodile Q*** files.

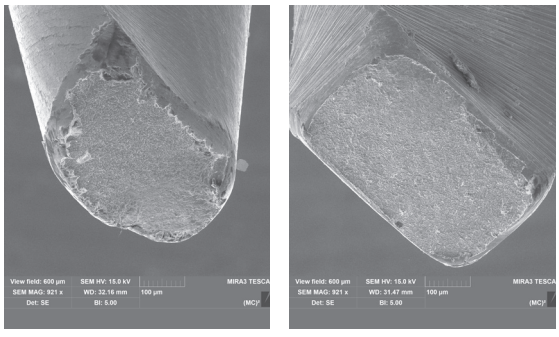
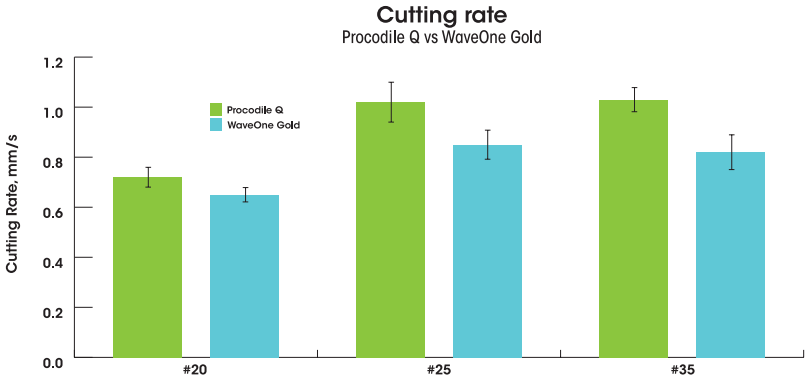


Fig 4. Size 025 Primary files after cyclic failure. Note the smoother surface and difference in core texture versus of the ***Procodile Q*** (left).

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 #020 to #035 files. The cutting rate was calculated by dividing the working time by the working length (10 mm) to the apex. Three canals were instrumented in sequence by each set of files. Microscopic evaluation under 40x magnification next to new files were conducted before continuing to detect the presence of unwinding.



Cutting Efficiency and Durability Summary: Overall cutting rate for ***Procodile Q*** was 16% faster than ***WaveOne Gold*** with full sequence instrumenting taking and average of 33.5s for Procodile Q to 39.5s for ***WaveOne Gold***. All Files survived past 2 canals. Detectable unwinding was detected after the 3 canal instrumented with ***WaveOne Gold*** in three #020, three #025, and one #035 ***WaveOne Gold*** files, and in only two #035 ***Procodile Q*** files.

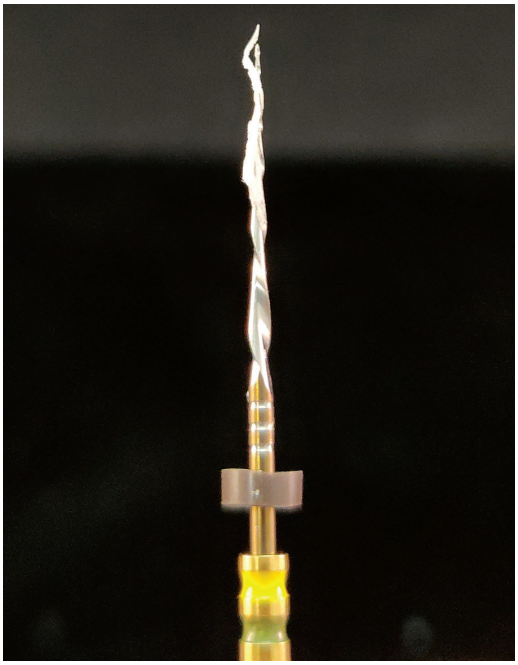


Fig 5. ***Procodile Q*** removes a large amount of debris after use.

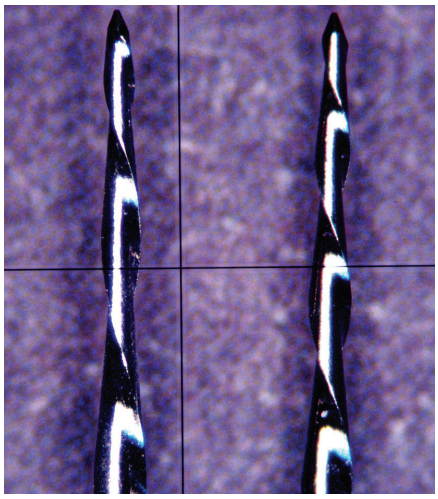


Fig 6. Procodile Q 035 File with slight unwinding after 3rd canal (unused file on right for comparison)

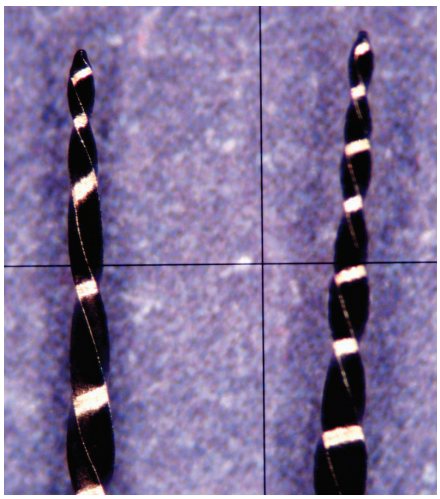


Fig 7. Wave One Gold File 025 with unwinding after 3rd canal

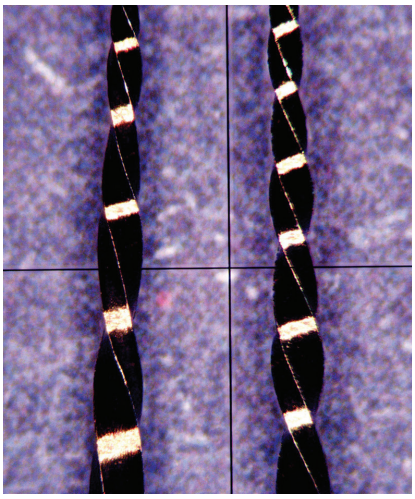


Fig 8. Wave One Gold 020 File with unwinding after 3rd canal

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Biomaterials Research Results

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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***.

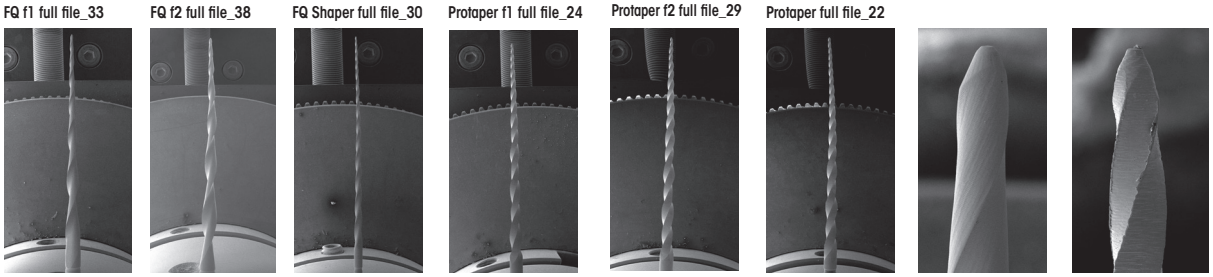


Fig 1. Full Length views of ***FQ Rotary Files*** and ***ProTaper Ultimate*** files.

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

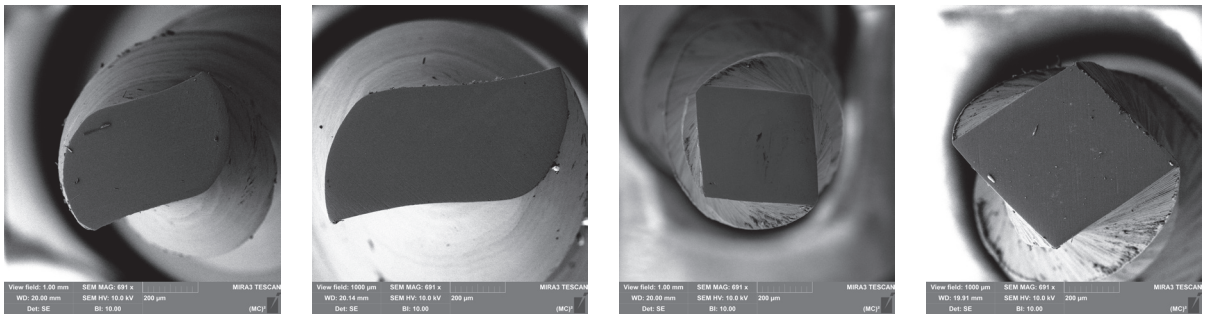


Fig 3. Cross-sectional views of 20.06 ***FQ Rotary Files*** and 20.07 ***ProTaper Ultimate*** rotary files sectioned at 8 mm and 13 mm from the tip. ***ProTaper Ultimate*** files feature a parallelogram design with a variable ~85-105° cutting edge. ***FQ Rotary Files*** feature a more acute cutting angle 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***.

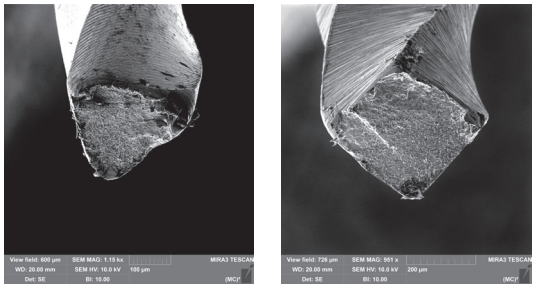
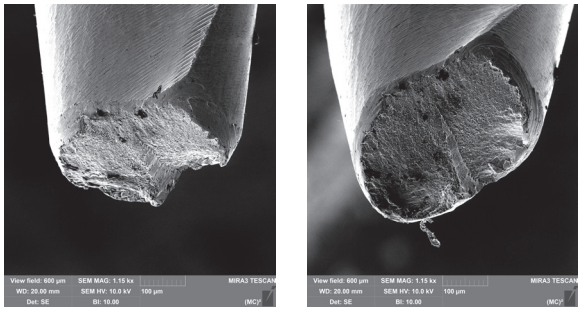


Fig 4. Size 15.03 and 20.04 files after cyclic failure



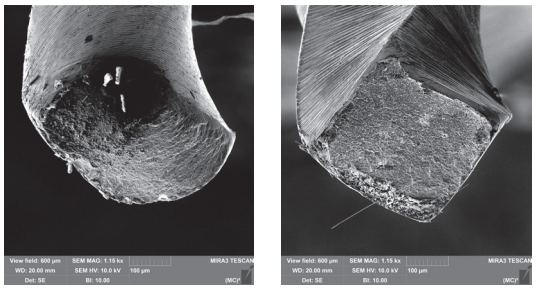


Fig 5. Size 20.06 and 20.07 files after cyclic failure

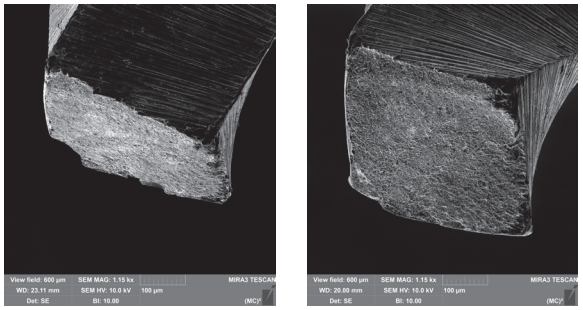


Fig 6. Size 25.06 and 25.08 files after cyclic failure.

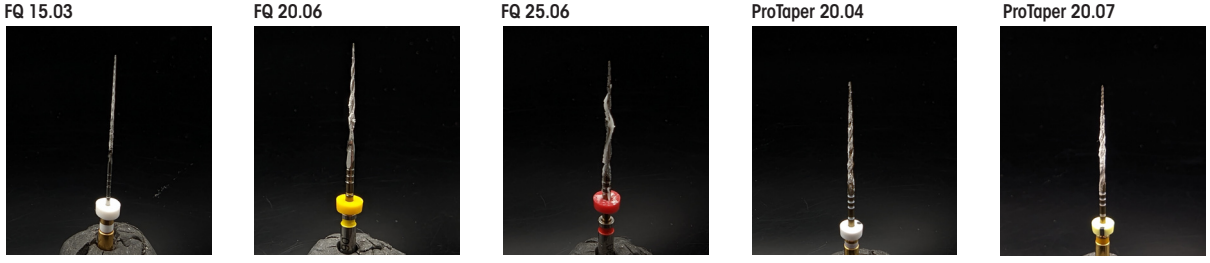


Fig 7. Images of debris removal after cutting evaluation. The amount of debris left on the file is variable with how much debris is removed from water irrigation in the simulated canal.