# Self-Adjusting File Cleaning-Shaping-Irrigation System Improves Root-filling Bond Strength

*Gustavo De-Deus, DDS, MS, PhD, Thais Accorsi-Mendonça, DDS, MS, PhD, Leandro de Carvalho e Silva, MSc, Carlos Augusto de Souza Leite, MSc, Diogo da Silva, DDS, and Edson Jorge Lima Moreira, DDS, MS, PhD*

## Abstract

**Introduction:** The aim of the present study was to assess the bond strength of root fillings in oval-shaped canals prepared with the self-adjusting file (SAF) system. **Methods:** A careful specimen selection resulted in 2 equal groups, each consisting of 12 extracted mandibular canines with oval canals that had vital pulps before extraction. One group was subjected to the SAF protocol, and the other group underwent conventional protocol, which was the ProTaper system with syringe-needle irrigation. Full-strength sodium hypochlorite was used as an irrigant for both groups. The teeth were obturated in a standardized way, filled with a lentulo spiral as the root filling, and then prepared for micropush-out assessment by using root slices of 1-mm thickness. Loading was performed on a universal testing machine at a speed of 0.5 mm/min$^{-1}$. The Student's *t* test for pairwise comparisons was applied to assess the effect of each preparation technique on the push-out bond strength. **Results:** All specimens showed measurable adhesive properties to root dentin. In addition, no premature failure occurred. The group-by-location interaction was significant ($P$ = .0071); thus, the group comparisons were dependent on the canal third. Overall, the push-out bond strength was the highest in the coronal third and the lowest in the apical third. SAF-prepared specimens displayed significantly higher bond strengths ($P$ = .0012, 0.51–5.9 MPa). **Conclusions:** The present study showed that SAF preparation markedly influenced root-filling push-out bond strength in oval-shaped canals. Further investigations are needed to provide a better understanding of the physicochemical modifications of the root dentin prepared with the SAF cleaning-shaping-irrigation system. *(J Endod 2013;39:254–257)*

## Key Words

Bond strength, debridement, instrumentation, oval canals, ProTaper, SAF, self adjusting file

From the Department of Endodontology, Grande Rio University, Rio de Janeiro, Rio de Janeiro, Brazil.

Address requests for reprints to Prof Gustavo De-Deus, Av. Henrique Dodsworth, 85, ap. 808 – Lagoa, Rio de Janeiro 22061-030, RJ, Brazil. E-mail address: endogus@gmail.com

0099-2399/$ - see front matter



http://dx.doi.org/10.1016/j.joen.2012.10.026

Despite the marked advances produced by the development of nickel-titanium (NiTi) rotary instruments, an ideal mechanical preparation of the root canal space has not been achieved to date (1). The entire dentinal walls of the root canal should be uniformly cut to remove the heavily contaminated inner layers and, at the same time, preserve healthy dentin tissue. However, micro–computed tomography high-resolution image studies have shown that the amount of mechanically prepared root canal surface is frequently less than 60% (2–4). This is because root canals regularly contain hard-to-reach areas that are practically unapproachable by the mechanical preparation technologies currently available (5, 6). In addition, conventional rotary NiTi preparations drastically pack hard-tissue dentin debris into the isthmus areas (7, 8), thus compromising the disinfection process as well as the filling phase (9).

Several recent studies on the self-adjusting file (SAF) system have shown superior results over the conventional rotary NiTi instrumentation in important aspects:

1. The ability to prepare oval-shaped canals (10)
2. Pulp tissue debridement (11)
3. The cleaning of hard-tissue debris (12)
4. The improvement of the filling ability (13)
5. The removal of residual gutta-percha after retreatment (14)

This innovative instrument consists of a hollow NiTi file composed of a metal lattice that is lightly abrasive and is claimed to remove dentin with a back-and-forth grinding motion (15, 16), which is used with continuous irrigation provided by a peristaltic pump. The vibrating metal lattice of the file is claimed to have a scrubbing effect on the canal walls. Siqueira et al (17) defined the SAF as a cleaning-shaping-irrigation system because it performs simultaneous chemomechanical preparation of the root canal space. It adapts itself to round, oval, or even long-oval cross sections of root canals, producing a better cleaning of the root canal space (11). Cross-section evaluation of prepared root canals with rotary files usually reveals hard-tissue debris in the uninstrumented recesses of the root canal space (13), which seems to block the flow of the thermoplasticized gutta-percha. On the other hand, buccal and lingual recesses are cleaned better in SAF-prepared canals, highlighting the effectiveness of the SAF as an irrigation system. The continuous flow of always fresh NaOCl, combined with the continuous agitation of the solution plus the scrubbing effect of the SAF, may explain this effective far-reaching cleaning effect. Therefore, it was possible to assume that the SAF biomechanical preparation may have a positive impact on the filling ability of the root canal space.

The present study was designed to assess the bond strength of root fillings in oval-shaped canals prepared with the SAF system. The ProTaper system (Dentsply Tulsa Dental Specialties, Tulsa, OK) was used as the reference technique for comparison, and the push-out bond strength was the outcome variable. The null hypothesis tested was that there was no significant difference in the dislocation resistance of the root fillings in oval-shaped canals prepared with either ProTaper NiTi rotary files or the SAF system.

## Materials and Methods

### Sample Selection

Seventy mandibular incisors were selected from a random collection of extracted teeth. Periapical radiographs were taken in the buccolingual and mesiodistal directions to select only teeth with single oval-shaped root canals, with a long:short cross-section diameter ratio of ≥2.5, 5 mm from the apex (9). This selection process resulted in 27 teeth, and 20 teeth were pair-matched according to their shape and dimension, which were based on visual examinations of the radiographs (11). One tooth from each pair was randomly assigned to 1 of the 2 experimental groups, 10 teeth per group (http://www.random.org).

## Root Canal Preparation

**ProTaper Preparation.** Thirteen teeth were prepared with ProTaper Universal instruments used at 300 rpm with 2 N cm of torque (XSmart; Dentsply Maillefer, Ballaigues, Switzerland). The following sequence was used: SX file (1/2 of the working length [WL]), S1 file (2/3 of the WL), S2 file (2/3 of the WL), and F1, F2, and F3 files (full WL). Shaping SX, S1, and S2 files were used in the canals with a buccal and lingual brushing motion, according to the anatomy of each root canal. Irrigation with 1 mL 5.25% NaOCl was used between each instrument and applied with a syringe and an open-end needle.

After every instrument, the needle was inserted as far as possible and retracted 2 mm before the application of irrigation. After the last instrument was used, the needle was placed 2 mm from the WL, and irrigation was applied. The smear layer was then removed with 3 mL 17% EDTA for 3 minutes. A total of 3 mL bi-distilled water was then used for 3 minutes as a final rinse.

**SAF Preparation.** Thirteen teeth were prepared with the SAF system (ReDent-Nova, Ra'anana, Israel). A glide path was established by using K-files to allow for insertion of a #20 K-file into the WL. The SAF file was operated by using in-and-out manual motion for 4 minutes in each canal, with continuous irrigation by using 5.25% NaOCl (0.4-mm amplitude and 5000 vibrations per minute). The irrigant was continuously provided by a VATEA peristaltic pump (ReDent-Nova) at a rate of 4 mL/min. The smear layer was then removed with 3 mL 17% EDTA for 3 minutes. A total of 3 mL bi-distilled water was then used for 3 minutes as a final rinse.

## Root Filling

The operator was blinded as to which tooth group was being filled. All canals were dried with paper points and obturated only with epoxy resin root canal sealer (AH Plus; Dentsply DeTrey, Konstaz, Germany) by using a lentulo spiral. Thus, a common bias related to the classification of the failure mode was avoided, because all failures have an undoubtedly adhesive nature when teeth are filled only with sealer. The teeth were radiographed at different angles to verify the quality of the filling procedure and the presence of bubbles. The specimens were placed in 100% humidity for 7 days to ensure complete setting of the sealer.

## Micropush-out Assessment

Each root was horizontally sectioned into six 1 ± 0.1 mm-thick serial slices (2 per root third) by using a low-speed saw with a diamond disk (125 × 0.20 × 12.7 mm) under continuous water irrigation. These 8 slices per root resulted in 60 slices per group or 20 slices per root segment (coronal, middle, and apical). The thickness of each slice was measured with a digital caliper with an accuracy of 0.001 mm (Avenger Products, North Plains, OR), and it was always within the 0.9- to 1.1-mm range. Each specimen was marked on its coronal surface with an indelible marker, and the exact thickness of each slice was measured by using a digital caliper to an accuracy of 0.04 mm. The fine-tune parallelism was ensured by a laser beam device, and the root filling of each sample was loaded with a 0.5-mm-diameter stainless steel cylindrical plunger for the apical thirds, 0.7-mm for the middle thirds, and 0.8-mm for the coronal third slices. The plunger tip was sized and positioned to touch only the root filling. The load was always applied in an apical-coronal direction to avoid any constriction interference caused by root canal taper during push-out testing. Loading was performed on a universal testing machine (Lloyd LRX-plus; Lloyd Instruments Ltd, Fareham, UK) at a crosshead speed of 0.5 $mm/min^{-1}$ until debonding occurred. Each cross section was coded and measured for the apical and coronal diameters of the obturated area by using a measurement optical stereomicroscope. A curve during the compression testing load/time was plotted during the test by using a real-time software program. To express the bond strength in megapascals, the load at failure recorded in newtons was divided by the area of the bonded interface (18).

## Data Presentation and Analysis

The outcome variable in the present study was the push-out bond strength (MPa); however, group-by-location interaction (root canal thirds) was also assessed. Preliminary analysis of the raw pooled data revealed a gaussian distribution (D'Agostino and Person omnibus normality test); thus, the Student's $t$ test for pairwise comparisons was applied to assess the effect of each preparation technique on the push-out bond strength. The alpha-type error was set at 0.05.

# Results

All specimens showed measurable adhesive properties to root dentin. In addition, no premature failure occurred. The group-by-location interaction was significant ($P$ = .0071); thus, the group comparisons were dependent on the canal third. Overall, the push-out bond strength was the highest in the coronal third and the lowest in the apical third (Fig. 1). SAF-prepared specimens displayed significantly higher bond strengths ($P$ = .0012, 0.51–5.9 MPa). The values of the push-out bond strength data in each experimental group are shown in Figure 1.

# Discussion

Significantly higher bond strengths were found for SAF-prepared canals compared with ProTaper-prepared ones. Therefore, the null hypothesis was rejected. The better results from the SAF-prepared canals indicate that this system may improve cleaning and shaping standards compared with the traditional NiTi rotary preparation (19–21), producing less hard-tissue debris during instrumentation (12). The rationale to explain the superior push-out bond strength found in SAF-prepared specimens lies in the fact that the cleaner the root canal space is, the better is the adaptation to the canal walls. A recent study showed that the SAF cleaning-shaping-irrigation system resulted in a significantly greater amount of gutta-percha inside the root canal space than when using the rotary ProTaper files with a conventional syringe-needle irrigation (11).

A further finding of the present study was that the level of the cross sections influenced bond strength values. This is in line with several studies in which bond strength values decreased in a corono-apical direction. This can be a result of the less patent tubules present in the apical direction (22, 23). The more complex structure of tubular dentin apparently makes itself more amenable to infiltration with epoxy resin than the sclerotic apical counterpart (24).

The present study had 2 methodological aspects that needed to be addressed. The first one was about attaining better control on the type of the failure mode. The root canal space was filled only with the sealer. Thus, a common bias related to the classification of the failure mode was avoided, because all failures have an undoubtedly adhesive nature (24). This also truly reflects the bond strength between the sealer and dentin (24). The second aspect was regarding the type of the sample.