ORIGINAL RESEARCH

SAF: Paving A Way to Minimal Invasive Endodontics

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Abstract

3D cleaning, shaping and obturation of root canals have always been the desired goal of endodontic Treatment which in many cases is difficult to attain. The introduction of NiTi rotary files made a major change in endodontic practice, making treatment easier, safer and faster. All these systems require several subsequent files. Recently, three different concepts of single file systems have been introduced:

1. The single file reciprocating working motion
2. Single file instrumentation using full 360 degrees rotational movement to be used in a full clockwise rotation
3. The Self Adjusting File (SAF).

Nevertheless, after 16 Years of intensive development, most of these instruments still share several drawbacks, the major one being the inability to three dimensionally clean and shape oval root canals. The self-adjusting File (SAF) System was designed to overcome many of the current drawbacks of rotary file systems. In this article, we will review the SAF system and its uniqueness in working & its advantages over other systems.

Key Words: Self Adjusting Files, SAF, Minimal Invasive Endodontics.

Introduction

The cleaning and shaping of the root canal is the key step in root canal treatment. Its aim is to remove all tissue debris from the root canal space while removing the inner layers of root canal dentin.[1] The success rate of root canal treatment varies from 31%–96%. Complete debridement of the root canal space using files and irrigation solutions is critical to improving endodontic success. However, instrumentation, irrigation solutions, and debris that contain necrotic tissue, microorganisms, pulpal fragments, and dentin particles may be extruded from the root canal space into the periapical region, resulting in postoperative inflammation and failure.[2] The goal of cleaning and shaping may be easily and reproducibly achieved with rotary files as far as relatively straight and narrow root canals with a round cross-section are concerned. Nevertheless, in flat oval-shaped root canals and in curved ones, this goal is not easy attainable.

Flat oval root canals are common in the distal roots of lower molars, upper and lower bicuspids, and lower incisors and canines. Asymmetrical, flat, tear-shaped cross-sections are another challenge. The buccal and lingual areas of such flat root canals and the area facing the isthmus in tear-shaped ones cannot be adequately prepared by current rotary files. Current technology may mislead the operator to believe that the canal has been adequately shaped when, in fact, recesses full of infected tissue and debris may have been left on the buccal and/or lingual sides of the area prepared by the rotary file. Another inherent problem with rotary-nickel titanium files is apical canal transportation in curved root canals. Transportation of the canal at this critical point can have two major drawbacks: first, the apical part of the canal on the inner side of the curvature may remain untouched and full of debris, and,

second, it may lead to ledging or even a subsequent perforation.

Another closely related problem is straightening of the root canal at the midroot section of curved root canals. Accurate length measurement is an essential prerequisite for the use of any rotary file. The thin nickel-titanium rotary files are extremely flexible and may negotiate even a canal with a rather sharp apical curve. When a rotary file accidentally passes the apical foramen of such a curved canal, it may soon lacerate or zip the apical foramen and form an oval opening with potential loss of the apical constriction. Unexpected separation of rotary nickel titanium files was and still is the major drawback. Nevertheless, to overcome the inherent remaining problems of the nickel-titanium instruments, a new concept in cleaning and shaping is warranted; hence, the self-adjusting file (SAF) was developed.[1]

Design and Mode of Operation

The SAF is a hollow file designed as a compressible, thin-walled pointed cylinder either 1.5 or 2.0 mm in diameter composed of 120- mm-thick nickel-titanium lattice (Fig 1). The 1.5-mm file may easily be compressed to the extent of being inserted into any canal previously prepared or negotiated with a # 20 K-file (Fig 2 & 3). The 2.0-mm file will easily compress into a canal that was prepared with a #30 K-file. The file will then attempt to regain its original dimensions, thus applying a constant delicate pressure on the canal walls.[3] When inserted into a root canal, it adapts itself to the canal's shape, both longitudinally (as will any nickel titanium file) and along the cross-section (Fig 4). The surface of the lattice threads is lightly abrasive (Fig 5), which allows it to remove dentin with a back-and-forth grinding motion.[1]

The SAF is operated with transline (in and out) vibrating handpieces with 3,000 to 5,000 vibrations per minute and amplitude of 0.4 mm. The SAF is inserted into the canal while vibrating and is delicately pushed in until it reaches the predetermined working length. It is then operated with in-and-out manual motion and with continuous irrigation using two cycles of 2 minutes each for a total of 4 minutes per canal. This procedure will remove a uniform dentin layer 60- to 75-mm thick from the canal circumference. The SAF file is designed for single use.[1] However, in curved & multi-rooted teeth, it is advisable to use more than one SAF to avoid deformation.[4]

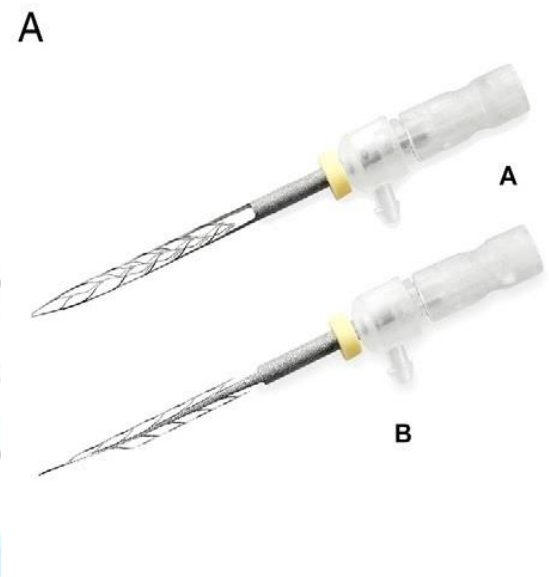

Fig 1: The SAF. (A) Shank for attachment to a transline vibrating handpiece (in-and-out motion). (B) Connector (hub) for the irrigation tube. Adapted from Metzger et.al.[1]

Fig 2: Glide path prepared by #20 K File. Metzger et.al.[1]

Fig 3: SAF in same canal (Compressed) Metzger et.al.[1].

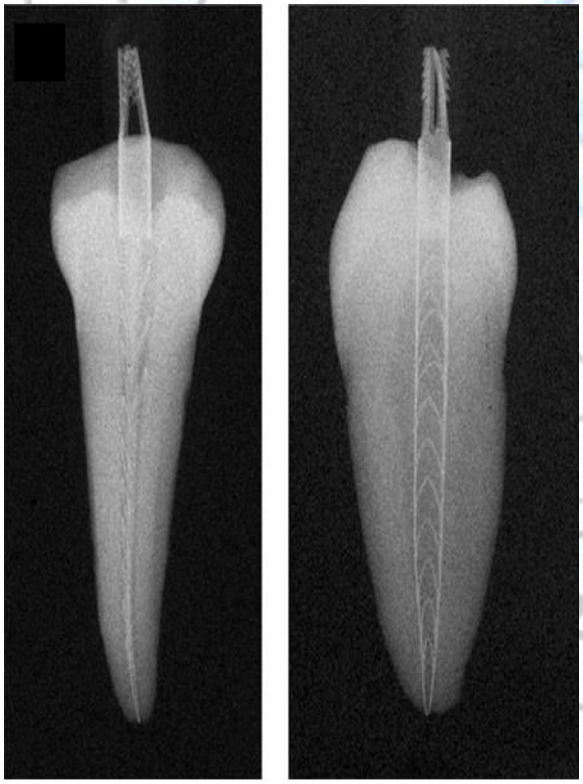

Fig 4: Three dimensional adaptation of the SAF file. The SAF inserted into the root canal of a lower bicuspid with a flat canal. Left: Bucco-Lingual projection. Metzger et.al.[1]

Fig 5: Abrasive surface of the SAF file (25 x magnifications) Metzger et.al[1]

A self-adjusting File always respects with canal's will

Most rotary file systems will find the widest part of the canal and gradually machine it, using several files of increasing diameter, to a wider canal with a round cross section.[1] In narrow canals with round cross section, these systems give excellent results but in oval, flat or tear shaped canals, these leave a recess full of debris & microorganism. The SAF is used as a single file (of either 1.5- or 2.0-mm diameter) that starts as a narrow, compressed, shape and gradually expands in the canal while removing a uniform layer of dentin from its walls. Because the file adapts itself to the cross-section of a given canal, a canal with a round cross-section is enlarged as a round canal, whereas an oval canal is enlarged as an oval canal of larger dimensions.[1]

Removal of uniform thickness of dentin and uniform remaining wall thickness

When operated in flat root canals, rotary nickel-titanium files may result in uneven thickness of the remaining dentin wall. This uneven thickness of the remaining dentin wall may be a predisposing factor for vertical root fractures. On the other hand, the SAF removes a uniform layer of dentin from the canal walls, thus resulting in a relatively uniform remaining dentin wall thickness and avoiding the previously mentioned risk[1]. Various studies showed SAF system causes less or no dentinal cracks.[5,6,7] SAF with filling sowed the highest fracture load due to uniform remaining wall thickness.[8]

Prevention of Canal Transportation

The SAF file is extremely flexible and pliable. It does not impose its shape on the canal but rather complies with its original shape. This is true both circumferentially and longitudinally.[1] It has no will of

its own. A study by Burroughs et.al shows SAF system shows less canal transportation than Profile Vortex & Typhoon files.[9]

When rotary files accidentally pass the apical foramen of an apically curved canal, because of misleading length measurement or failure to maintain the marker in place, they may soon ‘‘zip’’ the apical foramen and form an oval opening. The SAF, on the other hand, may be operated in such conditions even for few minutes with no zipping.[1]

High Durability

The SAF file is extremely durable and may go through rather severe abuse before a mechanical failure will occur. When torque durability was tested, the SAF can be turned 7*360° before separation with torque durability of 29.7 g/cm. These values are well beyond the ISO3630-1 requirement (1 * 360° rotation and 18 g/cm in the torque durability test) [1]

A buckling test is more relevant to study the endurance of the SAF. The SAF can endure more than 600,500 consecutive 6-mm type I free buckling cycles before any mechanical damage could be observed. This represents an equivalent of 120 minutes of a rather abusive operation at 5,000 vibrations per minute.[1]

After all this, the ultimate endurance test is the real-life test: operation in root canals. The SAF can be operated for 27 minutes in extracted human teeth before any structural failure appears. This represents more than 6 times the 4-minute operation time per canal, which is sufficient to achieve the desired results.[1]

It is of particular importance to note that even when structural failure did occur, it was not of the separation type that is encountered with other nickel-titanium files. Detachment of one of the arches at one of its ends was the typical mechanical failure.[1] The damaged file could easily be retrieved from the canal within few minutes using H-file without any additional dentin removal.[10]

Continuous Irrigation with Sodium Hypochlorite

Irrigation of the root canal with copious amounts of sodium hypochlorite during root canal treatment is widely recommended. The SAF operates with a continuous flow of the irrigant via VATEA system(Fig 6), thus allowing continuous fresh irrigant to be present in the canal at all times. The vibration of the file’s metal lattice within the irrigant facilitates its cleaning and debridement effects.[1]The SAF, operated with the continuous flow of irrigant alternating between sodium hypochlorite and EDTA, resulted in root canals that were free of debris and almost completely free of the smear layer.[11]

Fig. 6: The VATEA Irrigation System. Metzger et.al.[28]

Removal of the Smear Layer in the Apical Part of the Canal

As with any other mechanical device, the SAF forms a smear layer on the canal walls. This layer should be removed in order to allow intimate, unobstructed contact of antibacterial agents with bacteria at the orifices of dentinal tubules and also to optimize the sealer’s adaptation to the canal walls and thus prevent the future formation of a gap between them. A final wash with a chelating agent such as EDTA or citric acid has recently become widely used to remove the smear layer before obturation.[1] Around 80 % samples are rendered free from *E. faecalis.*[12] However preparation of most apical part remains a challenge.[13]

Root Canal Obturation

Root canal obturation of SAF-prepared root canals may be done by any of the common methods. Adaptation to the canal walls is possible even in flat canals because of the thorough cleaning of the otherwise difficult to clean recesses.[1] SAF system results in higher percentage of gutta-perch-filled area (PGFA) with thermoplasticized gutta-percha. The mean PGFA by the SAF system is 90.5% with 17.8% of the specimen had a PGFA ≥95%.[14]

Less Apical Extrusion

SAF instrumentation was associated with significantly less extrusion compared with the use of hand & rotary files.[15, 16] However, significant differences are not found in SAF and any other systems by Koçak et.al.[2]

Scrubbing effect

SAF cleans the canal by the scrubbing effect. The metal mesh of the SAF wall is intimately adapted to the canal wall and is continuously in motion, thus providing a scrubbing effect. The combination of scrubbing effect with the continuous flow of fresh, fully chemically active sodium hypochlorite results in highly effective cleaning of the canal walls from any attached materials.[17] The canal debridement quality is

more efficient than other rotary systems.[18] However acc. to Topcu et.al[19], WaveOne system shows a better result which contradicts the results of study conducted by Dietrich et.al.[20]

Use of SAF in retreatment

Additional use of SAF with rotary retreatment files has shown better removal of filling material.[21, 22,23,24,25]

Proposed Protocol for SAF system

A classification and also the protocol of using SAF effectively has been recently reported.[26] The classification was proposed taking into account the root canal size and patency. The root canals can either accommodate ISO #10, #15 or #20 and larger, passively without any instrumentation, referring them as difficult, medium or simple canals. The protocol for using the SAF effectively with possibly fewer mishaps was as follows:

Step 1: Glide path preparation

The glide path for accommodating a #20 K-file or larger not need any preparation of a glide path for using the SAF. Moderate or difficult canals allowing just the placement of a #15 or #10 K-files, a glide path is needed to be prepared till at least a #20 K-file is reaches the working length freely for the use of 1.5 mm SAF. Larger than #35 K-file then use of 2.0 mm SAF is effective.

Step 2: Canal instrumentation

On confirming the placement of the SAF until the working length, the file is used with short pecking strokes in- and-out continuously for 4 min with a simultaneous irrigation. The irrigation flow should be of 4 ml/min.

Step 3: Obturation

A combination technique may be used; cold lateral compaction, followed by vertical condensation with hot plugger, and followed by condensation with cold plugger.[27]

Conclusion

The SAF represents a new advent in endodontic file design and use. The SAF does not have a will of its own while preparing the root canals and is advantageous over currently available endodontic files. It also introduces a new era of minimally invasive endodontics. Based on the literature supports, it can be concluded that the SAF system can be a successful means to provide the unmet solution for successfully shaping the oval and oval-flat canals.

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