ENDODONTICS SIMPLIFIED

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Abstract

The preparation of the root canal system is essential for a successful outcome in root canal treatment. The development of rotary nickel titanium instruments is considered to be an important innovation in the field of endodontics.

During few last years, several new instrument systems have been introduced but the quest for simplifying the endodontic instrumentation sequence has been ongoing for almost 20 years, resulting in more than 70 different engine-driven endodontic instrumentation systems that are currently available to practitioners. But considering the current trends, where operators are choosing instrumentation technique by using only a small number of NiTi rotary files to decrease the learning curve and developing cost effective approach, single file endodontic file systems seems to be better alternative.

Recently many single file systems are available such as files such as, self adjusting file (SAF; ReDent-Nova, Raanana, Israel), Twisted File (TF) (SybronEndo, Orange, CA, USA), Reciproc (VDW, Munich, Germany), WaveOne (Dentsply Maillefer, Ballaigues, Switzerland) , One Shape (micro mega, france) and F2 ProTaper universal Ni-Ti rotary instrument (Tulsa Dentsply, Tulsa, OK, USA) systems are claims to be able to completely prepare and clean root canals with only one instrument.

Review (J Int Dent Med Res 2013; 6: (3), pp. 117-121)

Keywords: Single file, Twisted File, WaveOne, Reciproc, Self Adjusting File, F2 ProTaper, One Shape.

Received date: 11 November 2013 **Accept date:** 24 November 2013

Introduction

The preparation of the root canal system is essential for a successful outcome in root canal treatment[1]. Mechanical debridement of the root canals is meant to eliminate vital and necrotic tissues from the root canal system. Along with removal of infected dentin. Canal therapy also creates a space to facilitate disinfection by irrigants and medicaments and an optimal shape for three dimentional obturation.thus mechanical prepration and chemical disinfection are commonly considered together and reffered to chemo mechenical prepration.

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But considering the current trends, where operators are choosing instrumentation technique by using only a small number of NiTi rotary files to decrease the learning curve and developing cost effective approach, single file

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SYSTEMS

Waveone:

Recently waveone single file system (Dentsply, Maillafer) had been introduced which is designed to be used with a dedicated reciprocating motion motor. This system claims to be based on a single file and single use concept as one single file is able to completely prepare and clean the root canals and due to growing concerns regarding cross contamination[2] and instrument fracture. This file system was made to be used once only as plastic colour coding in the handle becomes deformed once sterilized, preventing the file from being placed back into the handpiece . It consists of three waveone files namely:

- WaveOne small file (yellow) is used in fine canals has tip size ISO 21with constant taper of 6% over its active portion.
- WaveOne primary file (red) is used in majority of canals has tip size ISO 25 with fixed taper of 8% from D1 to D3, whereas from D4 to D16, they have progressively decreasing taper.
- WaveOne large file (black) is used in a large canals has tip size ISO 40 with fixed taper of 8% from D1 to D3, whereas from D4 to D16, they have progressively decreasing taper.

Another unique design feature of the WaveOne is they have reverse helix and different cross sectional design over the active length. From D1 to D8, the WaveOne files have a modified convex triangular cross section with radial lands, whereas from D9 to D16, these files have convex triangular cross section. The design of the 2 WaveOne cross sections is further enhanced by changing pitch and helical angle along their active portion.

These files are made of a special NiTi alloy called M wire that is created by innovative thermal treatment process that improves flexibility, strength and cyclic fatique[3]. The WaveOne e3 motor with a 6:1 reducing handpiece is specially designed and programmed to drive the new WaveOne files in a reverse balanced force action.

The motor produces a unequal bidirectional file movement. The counterclockwise (CCW) movement is five times than the clockwise (CW) movement. CCW movement advances the instrument, engaging and cutting the dentine. CW movement disengages the instrument from the dentine before it can (taper) lock into the canal. After 3 engaging/ disengaging cutting cycles, the WaveOne file will have rotated 360, or turned one CCW circle. There are 3 critical distinctions with this novel, one, compared to continuous rotation, there is a significant improvement in safety, as the CCW engaging angle has been designed to be smaller than elastic metallurgical limit of the file. Two, enables the file to more readily advance towards the desired working length. Three, it strategically enhances auguring debris out of the canal[4].

F2 PROTAPER UNIVERSAL

With the Unequal bidirectional movement concept in the mind Dr Ghassan Yared came out with a single file F2 ProTaper technique where only one F2 ProTaper instrument was used in reciprocating movement to prepare the whole root canal. It is used in conjunction with 16: 1 reduction ratio contrangle connected to an ATR vision motor which allows reciprocating motion. The CW and CCW rotations are set on the motor at four- tenth and two- tenth of a circle. This means that after five reciprocating movements, the instrument completes one entire rotation. The rotational speed is set at 400 rpm. When instrument is rotated CW, it will screw in the canal. When rotated CCW, the instrument will unscrew out of the canal. As the CW rotation is greater than CCW rotation, the end result is a screwing in effect and advancement of the instrument in the canal[5].

The F2 instrument is used in the canal with a slow pecking motion and an extremely light apical pressure until resistance is encountered (i.e. until more pressure is needed to make the F2 advance further in the canal). The instrument is then pulled out of the canal, cleaned with a

gauze to remove the debris filling the flutes, and reinserted and employed in the same manner.

This step is repeated until the F2 reaches the working length. No further enlargement would be required for narrow and/or curved canals. For larger canals, hand files can be used after the F2 reaches the working length to complete the apical enlargement[6].

One of the most important aspects of the F2 instrument is the variable taper. This feature would provide an increased flexibility for this larger instrument which can be used in this technique to prepare severely curved canals. Limitation for the application of the F2 ProTaper is the presence of a sharp (non-gradual) canal curvature. In such a case, the instrumentation with the F2 would be carried to a level coronal to the curvature; the preparation of the apical part would then be completed with hand files[5].

Twisted files

The Twisted File (TF) (SybronEndo, Orange, CA,USA) system represents a quantum leap forward in endodontic capability over previous rotary nickel titanium (RNT) cleaning and shaping methods. TF is manufactured from a proprietary process of heating, cooling and twisting of nickel titanium in the rhombohedral crystalline phase (R phase) configuration (an intermediate phase between austenite-the phase at rest and martensite-the phase present during function). TF stands in distinction to other rotary nickel titanium (RNT) alternatives that are manufactured by grinding or produced using M-wire (Dentsply Tulsa Dental, Tulsa, OK, USA)[7] .

TF is available in 5 tapers and various tip sizes. These include: 12/25, 10/25, 08/25, 06/25/30/35, 04/25/40/50 in 23, and 27 mm lengths. Twisted file is colour-coded for easy identification.

The top band shows the taper and the bottom band the ISO tip size, they are laser marked. TF has triangular cross-section which enhances flexibility, generates less friction inside the canal walls due to a lack of peripheral lands. A variable pitch that minimizes the “screw-in” effect and allows debris to be effectively channelled out of the canal and is made from one piece of nickel titanium which gives TF more structural integrity than those that require the handle to be crimped onto the ground nickel titanium blank, also minimizes “wobble”during rotation[7].

TF is inserted passively and gently. TF will unwind in proportion to the excessive force used. TF is far more ductile than files manufactured by grinding. TF is always in motion either being inserted or withdrawn, but never held stationary in the canal. TF is inserted to resistance and withdrawn. This motion cuts approximately 5µm of dentin per insertion. The flutes of TF are wiped after every insertion. Irrigation and recapitulation should follow every insertion. Insertion is continuous, controlled, and takes approximately 2-3 seconds. TF is not pumped into the canal like a toilet plunger. Such use can lock the tip and cause instrument fracture. Manufacturer recommends 500 rpm for TF. Any electric motor can power TF. It can be used with or without torque control and auto reverse.

TF is the most flexible instruments, with a significant improvement in flexibility ($P< 0.05$). ranging from 100% to 250% over the other tested instruments. Cutting flutes are created by twisting the file, not grinding, eliminating micro fractures for greater strength. TF system was found to cut dentin efficiently with more uniform cutting than machined nickel-titanium endodontic files[8].

TF can prepare a .08 taper around a 90-degree curvature in approximately 3-4 insertions in a tooth that has been accessed correctly with a glide path. TF 3-4 times greater resistance to torsion and cyclic fatigue relative to ground files. The TF system eliminates the need for orifice openers[7]. TF system produced significantly less transportation and preserved the original canal to a greater degree[9]. The new manufacturing processes appeared to offer greater resistance to cyclic fatigue in a simulated canal model[10].

Self Adjusting File (SAF)

The SAF is a hollow file designed as a compressible, thin-walled, pointed cylinder, 1.5 mm in diameter, composed of a thin nickel-titanium lattice. During its operation, the file is designed to be compressed while inserted into a narrow root canal.

The file then attempts to regain its original dimensions, thus applying a constant delicate pressure on the canal walls. When inserted into a root canal, it adapts itself to the canal’s shape, both longitudinally (as will any nickel-titanium file) and also along the cross section[11,12]. In a round canal, it will attain a round cross-section, whereas in an oval or flat canal it will attain a flat

or oval cross-section, thus providing three-dimensional adaptation during the cleaning and shaping process[11,12]. Thus, its name, SAF, expresses this unique behaviour during its application.

The surface of the SAF lattice threads is lightly abrasive, designed for the removal of dentin with a back-and-forth grinding motion. A single SAF file is used throughout the procedure, starting as a compressed file that gradually enlarges in size during dentin removal with close adaptation to the canal walls[13].

The SAF is operated with transline (in and out) vibrating handpieces with 3,000 to 5,000 vibrations per minute at an amplitude of 0.4 mm. Such a handpiece may be the KaVo GENTLE power or equivalent combined with either a 3LDSY head (360_ free rotation; Kavo, Biberach Riss Germany) or MK-Dent head (360_ free rotation; MK-Dent, Bargteheide, Germany) or RDT3 head (80 rpm when free and stops rotating when engaging the canal walls, recently developed by Re-Dent-Nova, Ra'anana, Israel).

The vibrating movement combined with intimate contact along the entire circumference and length of the canal removes a layer of dentin with a grinding motion. The hollow design allows for continuous irrigation throughout the procedure. A special irrigation device (VATEA, ReDent-Nova) is connected by a silicon tube to the irrigation hub on the file and provides continuous flow of the irrigant of choice at a low pressure and at flow rates of 1 to 10 mL/min[11].

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[13].

Reciproc file

Reciproc (VDW, Munich, Germany) is a single file reciprocating system that is used in a special automated battery operated endomotor. The instruments are used at 10 reciprocation per second, which is equivalent of approximately 300 rpm. The angle of the counter clockwise cutting direction is greater than the angle of the clockwise disengaging direction (Manufacturer claims 150 CCW and 30 CW). Due to this it is claimed that the instrument continuously advances towards the apex of the root canal. Consequently very light apical pressure should be applied on the instrument[14].

Moreover this movement kinemetics also reduces the risk of cyclic fatique caused by tension and compression[15,16]. The angles of reciprocation are specific to the design of the particular instruments and are programmed in an electronic motor. In general, reciprocating root canal preparation is an evolution of the balanced force technique that allows shaping of even severely curved canals with hand instruments to larger apical diameters[17].

These instruments are made of a special NiTi-alloy called M-Wire that is created by an innovative thermal-treatment process to increase flexibility and resistance to cyclic fatigue[18,19]. Reciproc files are available in different sizes[14] :

- R25 has a diameter of 0.25 at its tip and 8% taper from D0-D3, which gradually decreases upto the shaft
- R40 has a diameter of 0.40 at its tip and 6% taper from D0-D3, which gradually decreases upto the shaft
- R50 has a diameter of 0.50 at its tip and 5% taper from D0-D3, which gradually decreases upto the shaft

The manufacturer of Reciproc instruments does not strictly recommend creating a glide path when using the reciprocating instrumentation. Reciproc instruments have S shaped cross section and possess sharp cutting edges[14].

ONESHAPE:

The OneShape file (micro mega) is a new NiTi instrument that is used in a conventional continuous rotation at 400 rpm for root canal preparation. The One Shape instrument has a safety tip and is 25 at the tip with a 0.06 taper. It has a unique design of three variable cross-section zones along the blade.

The apical zone presents a variable 3-cutting-edge design. The middle, prior to the transition, has a cross-section that progressively changes from 3 to 2 cutting edges. The last (coronal) is provided with 2 cutting edges. This deign offers an optimal cutting action in three zones of the canal. Each instrument has been electro polished to enhance cutting efficiency. One Shape flexibility and unique downward movement ensures an effective apical progression.

Minimal fatigue along the length of the file virtually eliminates the risk of separation. The variable pitch of One Shape reduces instrument screwing effects. One Shape also has a anti Breakage Control in which a instrument will unwind to avoid separation[20].

While preparing the root canal and before switching on to one shape file patency to a size 15 hand file is achieved and then One Shape instrument is taken down to two thirds of the working length using an in-and-out movement without pressure while performing an upward circumferential filing movement in order to pre-enlarge the canal. Withdraw and clean the flutes, irrigate and check canal patency.

After that Place the OS file 3 mm from working length with an in-and-out movement without pressure and again clean and irrigate and check canal patency. At final steps Place the One Shape instrument into the canal and take it to working length performing the in-and-out movement without pressure. Working length can be reached in one or more passages (file withdrawal, cleaning the file, irrigation and patency check) depending on the complexity of the canal anatomy [20].

The One Shape instrument is delivered in a sterile blister pack and should be used on one tooth and then discarded. Also, the practitioner can use their current endodontic motor and endodontic handpiece with the One Shape instrument. One Shape is optimally designed to work on the majority of all endodontic cases[20].

Conclusions

Now days, there is pursuit for simplifying endodontic by using systems that use fewer files, decreases the learning curve, working time, cross contamination and increases efficiency, safety.

Moreover a single file technique has been conceptualized for decades. But from past few years these systems came into the reality. In the present review we have discussed all the single file systems present in market now days.

However many research has already be done on these single file systems, but further laboratory experiments and clinical trials are required for better application of these file systems.

Declaration of Interest

The authors report no conflict of interest and the article is not funded or supported by any research grant.

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