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Reciprocation in Endodontics

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Abstract

Last few decades have witnessed drastic changes in the way we try to shape and clean the root canal system of teeth. These changes are seen in the type of instrumentation and the way in which they are used. There have been metamorphic advancements in the metallurgy of the instruments used in endodontics and this change has led to modifications in the way these instruments were used. The introduction of NiTinol has been proven revolutionary in the field of endodontics. Further various proprietary heat treatment processing procedures (e.g. blue and gold heat treated instruments) and mechanical machining procedures (e.g. twisting, electric discharge machining) have been developed to increase the mechanical properties of NiTi endodontic instruments. Such thermo mechanical procedures have made it possible for clinicians to use rotary endodontic NiTi instruments in reciprocation movement which has been proved to be highly efficient. Reciprocating endodontic file systems have been shown to be time saving, minimize cross contamination and more importantly have superior mechanical properties like cyclic fatigue resistance.

Keywords: Reciprocation, Wave One, Reciproc, Wave One Gold, Reciproc Blue,

Introduction

Reciprocation is a recently developed innovation in field of endodontics which has been gaining popularity since its introduction as it has been claimed to give easier treatment. Reciprocation had been used with stainless steel files but when applied to NITI files, it differs in various aspects from stainless steel files.[1] Conventional NiTi instruments are subjected to structural fatigue when

rotated in root canals. Increased torsion and flexural fatigue eventually lead to their fracture. Torsional fracture occurs when the tip or any other part of the rotating instrument binds to canal walls while the rest of the file keeps turning. Flexural fatigue is due to bending stress when instrument that has been already fatigued is placed under further stress. The instrument does not bind to the root canal walls but rotates freely until fracture of the instrument occurs at the point of maximum flexure. Flexural fatigue is directly dependent on the anatomy of canal and greater for curved root canals.[2]

History and evolution

Yared in 2008 experimented by using ProTaper F2 instrument in alternating reciprocating movement.[3] He used a single F2 rotary file for complete instrumentation of canal but in reciprocating motion. This file was used only after the initial canal negotiation with small size hand files like 8, 10 no. k files. His work was based on the balanced force principle described by **Roane et al** in 1985[4] and **Thompson's** dissertation on degree of rotation a file can undertake before breaking.[5] Currently used reciprocating files are made of heat treated NITI alloys and are single use with greater taper. The cutting motion utilised are asymmetric clock wise or counter clock wise rotation.[6-7]

Mechanical properties

Rotary endodontic instruments have been proven to have less deformations and consequently less instrument seperations.[8-9] Reducing the incidence of breakage was the main goal for the development of reciprocating instruments. Alternate reciprocation and rotation movements make these instruments to travel shorter circumferential distance as compared to instruments in continuous rotation. This prevents them from being subjected to higher stresses inside the canal during biomechanical preparation. This accounts for their improved cyclic fatigue resistance as compared to rotary instruments. Game changing innovations in metallurgy of NITINOL and their thermo mechanical treatments have added to increase the cyclic fatigue resistance, flexibility and torsional fatigue resistance.

According to **Plotino et al (2015)**[9]

- Reciprocation extends the life span of instruments
- Cyclic fatigue resistance depends on the amplitude of reciprocation
- Reciprocation does not reduce the cutting efficiency of the files tested
- Cutting efficiency of reciprocating and rotary instruments is at par.
- Reciprocation preserves the original canal anatomy.
- The cleaning effectiveness of reciprocating files is comparable to full rotary file sequence systems
- Reciprocating single files reduce the shaping time.
- The results of published studies show that the use of reciprocating files would lead to fewer or an equivalent amount of dentine micro cracks compared with full sequence rotary systems.
- Dentine micro cracks occur independently of the type of file and its kinematics RFs can promote significant bacterial reduction, but, like rotary full sequence systems, they are not able to completely disinfect the RCS.
- The ability of RFs to extrude less debris than rotary files remains a matter of debate
- Reciprocating files are effective in removing root canal filling material in less time as compared to rotary files, yet no system is able to remove the filling material completely from the RCS.

File systems based on reciprocation

Wave One Single File Reciprocating System (2011)[10]

The new WaveOneNiTi file system from DENTSPLY Maillefer is a SINGLE-use, SINGLE-file system to shape the root canal completely from start to finish. Shaping the root canal to a continuously tapering funnel shape not only fulfils the biological requirements for adequate irrigation to rid the rootcanal system of all bacteria, bacterial by-products and pulp tissue, but also provides the perfect shape for 3-D obturation with gutta-percha.

In most cases, the technique only requires one hand file followed by one single WaveOne file to shape the canal completely. The specially designed NiTi files work in a similar but reverse “balanced force” action using a pre-programmed motor to move the files in a back and forth “reciprocal motion”. The files are manufactured using M-Wire technology, improving strength and resistance to cyclic fatigue by up to nearly four times in comparison with other brands of rotary NiTi files.

There are three files in the WaveOne single-file reciprocating system available in lengths of 21, 25 and 31mm

1. The WaveOne Small file is used in fine canals. The tip size is ISO 21 with a continuous taper of 6%.
2. The WaveOne Primary file is used in the majority of canals. The tip size is ISO 25 with an apical taper of 8% that reduces towards the coronal end.
3. The WaveOne Large file is used in large canals. The tip size is ISO 40 with an apical taper of 8% that reduces towards the coronal end.

Fig.1

The instruments are designed to work with a reverse cutting action. All instruments have a modified convex triangular cross-section at the tip end and a convex triangular cross-section at the coronal end.

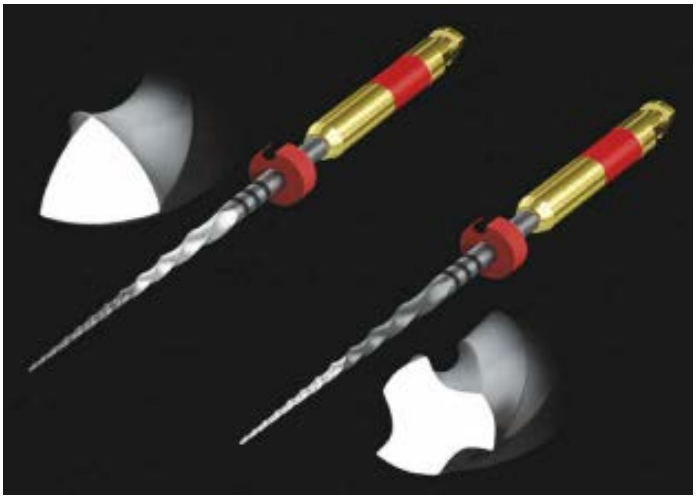


Fig.2

This design improves instrument flexibility overall. The tips are modified to follow canal curvature accurately. The variable pitch flutes along the length of the instrument considerably improve safety.

Because there is a possibility of cross-contamination associated with the inability to completely clean and sterilize endodontic instruments9 and the possible presence of prion in human dental pulp tissue, all instruments used inside root canals should be single use WaveOne instruments are a new concept in this important

standard of care, as they are truly single use. The plastic color coding in the handle becomes deformed once sterilized, preventing the file from being placed back into the hand piece

Design

Strategically, only 1 file is generally utilized to fully shape virtually any given canal. However, there are 3 WaveOne files available to effectively address a wide range of endodontic anatomy commonly encountered in everyday practice. The 3 WaveOne instruments are termed Small (yellow 21/06), Primary (red 25/08), and Large (black 40/08). The Small 21/06 file has a fixed taper of 6% over its active portion. The Primary 25/08 and the large 40/08 WaveOne files have fixed tapers of 8% from D1-D3, whereas from D4-D16, they have a unique progressively decreasing percentage tapered design. This design serves to improve flexibility and conserve remaining dentin in the coronal two-thirds of the finished preparation. Another unique design feature of the WaveOne files is they have a reverse helix and 2 distinct cross-sections along the length of their active portions . From D1-D8, the WaveOne files have a modified convex triangular cross-section, whereas from D9-D16, these files have a convex triangular cross-section. The design of the 2 WaveOne cross-sections is further enhanced by a changing pitch and helical angle along their active portions. The WaveOne files have noncutting modified guiding tips, which enable these files to safely progress through virtually any secured canal. Together, these design features enhance safety and efficiency when shaping canals that have a confirmed, smooth, and reproducible glide path.

Advanced Niti Alloy

Technological improvements in NiTi metallurgy have generated a new supermetal, commercially termed M-wire. Engineers can identify the desired phase-transition point between martensite and austenite and produce a more clinically optimal metal than traditional NiTi itself. Studies have shown that M-wire technology significantly improves the resistance to cyclic fatigue by almost 400% compared to commercially available 25/04 NiTi files.10 The good news is that reducing cyclic fatigue serves to clinically decrease the potential for broken instruments.

Reciprocation Movement

The e3 motor (Dentsply Tulsa Dental Specialties) is specially engineered and programmed to drive the new WaveOne reciprocating files. This motor produces a feature-specific, unequal bidirectional file movement. Because of the reverse helix design, the CCW engaging angle is 5 times the CW disengaging angle. Additionally, it should be noted, this motor can drive any market version file system in full CW rotation at the desired speed and torque.

Fig. 3

There are 3 critical distinctions with this novel, unequal bidirectional movement. One, compared to continuous rotation, there is a significant improvement in safety, as the CCW engaging angle has been designed to be smaller than the elastic metallurgical limit of the file. Two, opposed to all other reciprocating systems that utilize equal bidirectional angles, the WaveOne system utilizes an engaging angle that is 5 times the disengaging angle. Fortuitously, after three engaging/disengaging cutting cycles, the WaveOne file will have rotated 360º, or turned one CCW circle. This unique reciprocating movement enables the file to more readily advance toward the desired working length. Three, compared to an equal bidirectional movement, an unequal bidirectional

movement strategically enhances auguring debris out of the canal. Auguring debris in a coronal direction promotes the biological objectives for preparing canals, 3D disinfection, and filling root canal systems.

Single File / Single Use Concept

The WaveOne technique is both a single-file and single-use concept. As stated, it is a single-file concept given that one single file is able to transition a secured canal to a well-shaped canal, in most instances. Further, appreciate that a single WaveOne file is frequently used to prepare multiple canals in a single furcated tooth, performing a significant amount of work. The WaveOne concept must be considered a single-use concept due to the obvious stress and wear on the active portion of the file. This is in line with the growing concern in the dental community, especially in institutional settings, that all endodontic files be considered single-use. The rationale behind this legitimate concern is the documentable potential for cross-contamination between and among patients, regardless of the sterilization protocol utilized.

Although there are 3 WaveOne files, the Primary 25/08 file is invariably used first in any canal that has a confirmed, smooth, and reproducible glide path equivalent to at least a loose 10 file. The WaveOne development team has prepared several thousand canals over the past 4 years. From our collective experiences, our group can report that the primary 25/08 file will produce an optimal final shape in almost 90% of all canals, regardless of their length, diameter, and curvature. However, in longer, narrower, and more curved canals, even when the 10 file is loose at length, the Primary 25/08 WaveOne file will more predictably advance to the terminus of the canal when the glide path is expanded.

The Small 21/06 WaveOne file is used when the Primary 25/08 WaveOne file will not progress apically through a smooth reproducible glide path. The 21/06 is designed to work in smaller diameter, longer length, or more apically curved canals. In certain canals, when this file reaches the working length, the clinician may deem the preparation completed or, alternatively, may desire more deep shape. In these instances, the Small 21/06 is considered a “bridge file” because it promotes safety when transitioning back to the 25/08 WaveOne file. Even in these instances, the WaveOne technique is still a safe and efficient 2-file sequence compared to virtually all other mechanical shaping systems. The Large 40/08 WaveOne file is used to complete the shape in larger diameter canals that are typically straighter. Examples include certain maxillary incisors, single-canal bicuspids, and larger diameter canals within maxillary and mandibular molar teeth. Recall, the usual WaveOne protocol is to initiate shaping procedures using the primary 25/08 file. However, after carrying the Primary 25/08 file to the working length, gauging procedures may confirm that the foramen is bigger than 0.25 mm. In these instances, the clinician will require the 40/08 WaveOne file to fully shape and finish these larger canal systems. With experience, the clinician will learn to recognize these larger and more straightforward canals and is encouraged to initiate canal preparation procedures utilizing only the 40/08 WaveOne file.

Wave One Gold (2015)[11]

WaveOne GOLD instruments are manufactured utilising a new DENTSPLY proprietary thermal process, producing a super-elastic NiTi file. The gold process is a post manufacturing procedure in which the ground NiTi files are heat-treated and slowly cooled. From a technical perspective, the heat treatment modifies the transformation temperatures (austenitic start and austenitic finish), and this has a positive effect on the instrument properties. While this process gives the file its distinctive gold finish, more importantly, it considerably improves its strength and flexibility far in excess of its predecessor.

DENTSPLY internal testing has shown the following: the cyclic fatigue resistance of WaveOne GOLD Primary is 50% greater than that of WaveOne Primary (which itself was twice as great as most standard rotary file systems), and the flexibility of WaveOne GOLD Primary is 80% greater than that of WaveOne Primary.

Design features

There are four tip sizes in the WaveOne GOLD single- file reciprocating system: Small (20.07, yellow), Primary (25.07, red), Medium (35.06, green) and Large (45.05, white) , available in 21, 25 and 31mm lengths.

Fig.4

The various tip sizes and tapers afford the clinician the ability to clinically prepare a wider range of apical diameters and endodontic anatomy commonly encountered in daily practice. Canal preparations that have sufficiently tapered resistance form are ideal for irrigant exchange and removal of debris, thus promoting 3-D disinfection and filling of the root canal system. WaveOne GOLD has active cutting lengths of 16mm, shortened 11mm handles for improved posterior access and the same expanding ISO color-coded ABS ring as WaveOne, maintaining the philosophy of single use. Variable and reducing tapers ensure a more conservatively shaped canal with greater preservation of tooth structure at D16, the coronal extent of the preparation .

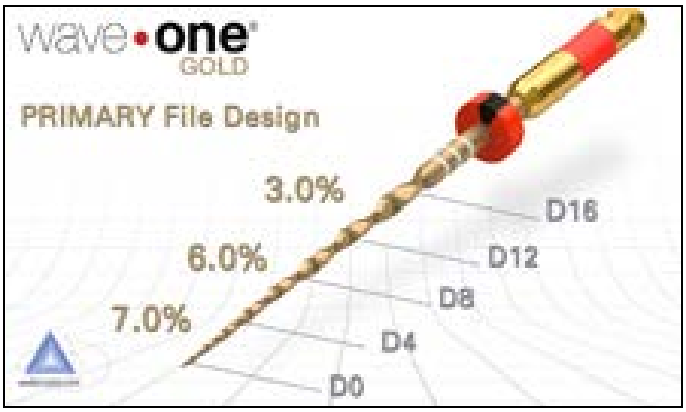


Fig. 5

While the concepts of “minimally invasive endodontics” lack documented and meaningful studies, any shaping objective that removes less of the existing tooth structure while optimising efficient 3-D irrigation and obturation is a positive step in an effort to preserve the integrity of the natural tooth. The cross-section of WaveOneGOLD is a parallelogram with two 85-degree cutting edges in contact with the canal wall, alternating with a patented DENTSPLY off-centredcrosssection where only one cutting edge is in contact with the canal wall.

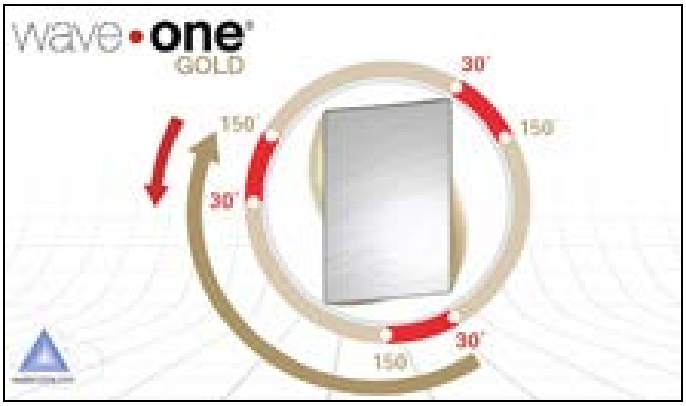


Fig. 6

Decreasing the contact area between the file and the canal wall reduces binding (taper lock) and, in conjunction with a constant helical angle of 24 degrees along the active length of the instrument, ensures little or no screwing in. The additional space around the instrument also ensures

additional space for improved debris removal. The tip of WaveOneGOLD is oval, roundly tapered and semi-active, modified to reduce the mass of the center of the tip and improve its penetration into any secured canal with a confirmed, smooth and reproducible glide path.

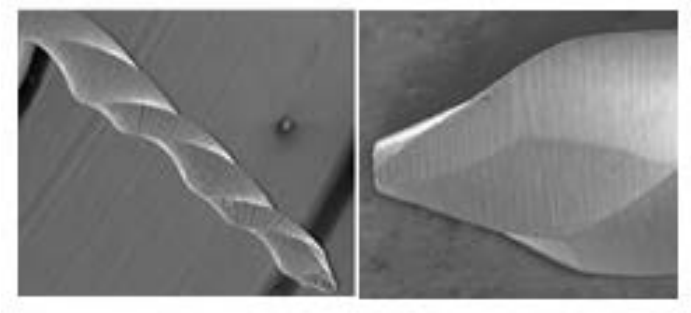


Fig.7

Wave one gold tips under SEM

Collectively, these design features result in a reciprocating movement that is very smooth, eliminating the need to push on the file, and thereby promoting safety and considerably improving cutting efficiency. This reduces shaping time by a further 19% in canals when compared with WaveOne.

Reciprocating movement

WaveOne GOLD files are designed with a reverse cutting helix, engage and cut dentine in a 150-degree counterclockwise (CCW) direction and then, before the instrument has a chance to taper lock, disengages 30 degrees in a clockwise (CW) direction. The net file movement is a cutting cycle of 120 degrees and therefore after three cycles the file will have made a reverse rotation of 360 degrees.

Fig.8

The X-Smart iQ launched in conjunction with WaveOne GOLD is an endodontic motor and cordless 8:1 handpiece designed for reciprocation and continuous motion. The handpiece is Bluetooth controlled by a DENTSPLY Apple iOSiQ app downloaded on to an iPad mini 2 (Apple). As a complete digital solution, it is designed for all stages of the endodontic procedure, including patient management, file selection, torque control training and patient education. The X-Smart iQ also offers electronic apex locator functionality. Currently available DENTSPLY reciprocating file motors and their respective handpieces, the X-Smart Plus motor (Rest of the World) and Pro-Mark and e3 Torque Control motors (North America), can be used without modification when using the complete range of WaveOne GOLD files. All reciprocating file motors are preprogrammed to produce the reverse bidirectional movement, but the CCW/CW angles, torque and speed settings cannot be altered. These motors can, of course, be used for continuous rotation when the clinician is able to adjust the speed and torque, as desired.

Shaping technique

- Establish straight-line coronal and radicular access with emphasis on flaring, flattening and finishing the internal axial walls.
- In the presence of a viscous chelator, use a #10 hand file to verify a glide path to length. In more restrictive canals, use a #10 hand file in any region of the canal to create a glide path.
- Expand this glide path to at least 0.15mm using either a manual or a dedicated mechanical file, such as the ProGlider or PathFile (DENTSPLY).
- Initiate the shaping procedure with the Primary file in the presence of sodium hypochlorite
- Use gentle inward pressure and let the Primary file passively progress through any region of the canal that has a confirmed glide path. After shaping 2–3mm of

any given canal, remove and clean the Primary file, irrigate, recapitulate with a #10 hand file and re-irrigate.

- Continue with the Primary file, in two to three passes, to pre-enlarge the coronal two-thirds of the canal.
- In more restrictive canals, use a #10 hand file in the presence of a viscous chelator and negotiate to the terminus of the canal. Gently work this file until it is completely loose at length. • Establish working length, confirm patency and verify the glide path.
- Expand this glide path to at least 0.15mm using a manual or mechanical glide path file.
- Carry the Primary file to the full working length in one or more passes. Upon reaching working length,remove the file to avoid over-enlarging the apical foramen. Inspect the apical flutes; if they are loaded with dentinal debris, then the shape is finished
- If the Primary file does not progress, use the Small file (020.07 yellow) in one or more passes to working length and then use the Primary file to working length to optimise the shape.
- When the shape is confirmed, proceed with 3-D disinfection protocols.

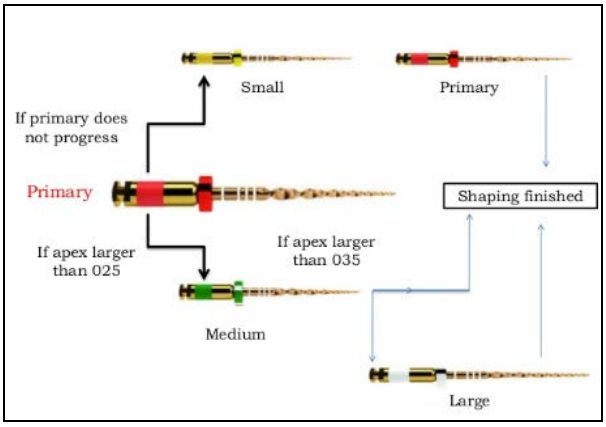


Fig. 9

Obturation solutions

Obturation of the root canal system is the final step of the endodontic procedure. The WaveOne GOLD system includes matching paper points, guttaperchapoints and Thermafilobturators. The new nanotechnology engineered gutta-percha points with their extended heat flow are ideal for all warm vertical compaction (WVC) techniques. WaveOne GOLD shapes can also be effectively obturated with GuttaCore (DENTSPLY), the cross-linked gutta-percha core obturator.

Wave One Gold Glider (2017)[12]

Fig. 10

WaveOne Gold Glider is a single-file, single-use glide path file that uses the exact same unequal bidirectional clockwise/counterclockwise angles as WaveOne Gold shaping files. With Gold-wire metallurgy, increasing tapers from 2% to over 6% along its active portion, and diameters of 0.15 mm at D0 and 0.85 mm at D16, pre-shaping canals has never been safer, faster or easier. Gold-wire technology has been shown to significantly improve flexibility and the resistance to cyclic fatigue compared to non-heat-treated files. A progressively tapered design over the active portion of a single file reduces the potential for taper lock and the dangerous screw effect.

Because of its design, metallurgy, and unique movement, Gold Glider cuts a safer, faster and more fully tapered pathway to length compared to a fixed tapered stainless steel size 15 hand file.

Gold Glider Features

- One single mechanical glide path file
- Progressive tapers from 2% to 6%
- Offers smooth "glide path" transition
- Gold-wire metallurgy
- Reciprocating movement (as compared to ProGlider's full rotary)
- Unequal bidirectional angles

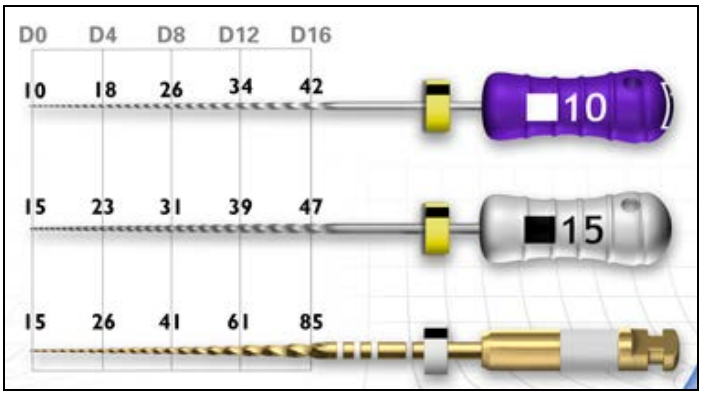


Fig. 11

Technique

- Prepare straightline access to canal orifice.
- In the presence of a viscous chelator, explore the canal up to a size 10 hand file
- Establish working length, confirm patency and verify a smooth, reproducible glide path.
- In preparation for using the selected Glider, set the motor to manufacturer prescribed settings
- In the presence of NaOCl, “float” the selected Glider into the secured canal and passively “follow” the glide path.
- Continue with the selected Glider in one or more passes until the full working length is reached.
- Upon removing the selected Glider, irrigate the expanded glide path, recapitulate and re-irrigate.
- Reconfirm the working length before shaping the canal with rotary or reciprocating mechanical files.

Reciproc File System(VDW)[13]

In reciprocation, the instrument is driven first in a cutting direction and then reverses to release the instrument. One complete rotation of 360° is completed in several reciprocating movements. The angle in the cutting direction is greater than the angle in the reverse direction, so that the instrument continously progresses towards the apex. The angles of reciprocation are precise and specific to the design of the RECIPROC® instrument and to VDW endo motors. They are designed to be smaller than the angle settings where the elastic limit of the instrument would be met, thus minimising the risk of instrument fractures.’

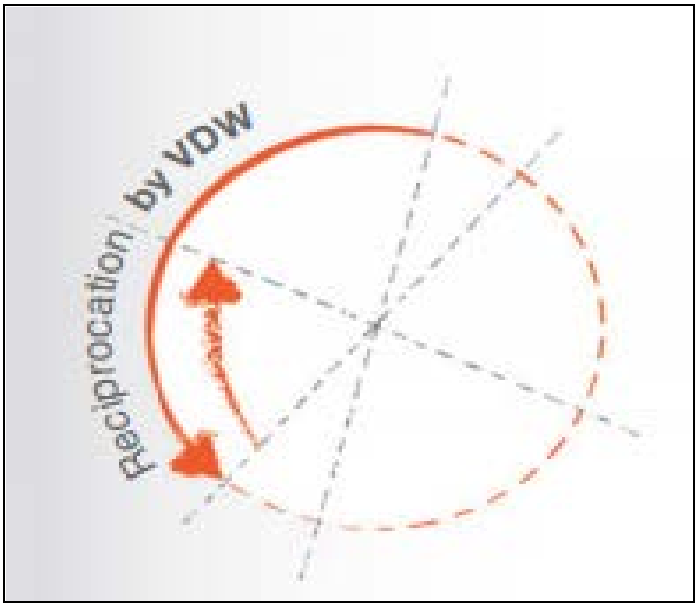


Fig. 12

RECIPROC® Instruments

RECIPROC® instruments are marked with the ISO colour of the instrument tip size for easy identification.

- R25 prepares the root canal to a diameter of 0.25 mm with a taper of .08 over the first apical millimetres.

Fig.13

- R40 prepares the root canal to a diameter of 0.40 mm with a taper of .06 over the first apical millimetres.

Fig. 14

R50 prepares the root canal to a diameter of 0.50 mm with a taper of .05 over the first apical millimetres.

Fig. 15

Instrument Design

RECIPROC® instruments have been specifically designed for use in reciprocation. RECIPROC® has a non-cutting tip.

Fig. 16

RECIPROC® is produced with M-Wire® nickeltitanium. Increased cyclic fatigue resistance is achieved through the use of this alloy produced in an innovative thermal-treatment process. M-Wire® has both greater resistance to cyclic fatigue and greater flexibility than traditional nickel-titanium.

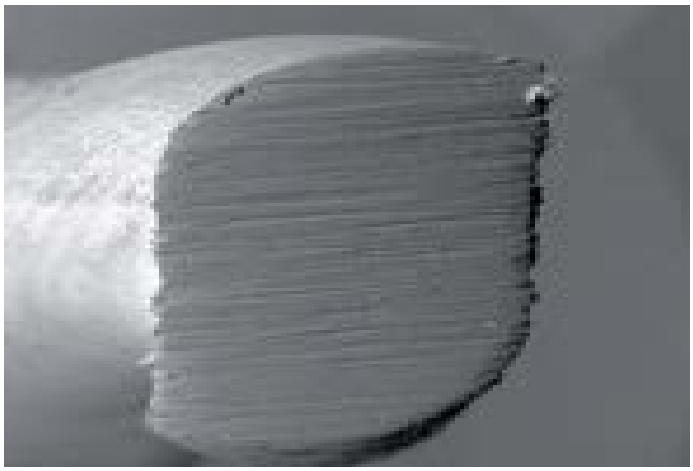


Fig. 17

RECIPROC® instruments are designed to be used as a single instrument. That means that one instrument only is required to prepare a root canal. The shape obtained by the RECIPROC® instrument enables effective irrigation and obturation with both cold and warm techniques.

Preparation with RECIPROC®

First Step

Ensure you have achieved a straight line access to the root canal entrance. It is not necessary to widen the root canal entrance with a Gates Glidden drill or an orifice opener. The design of the RECIPROC® instrument allows any obstructions in the coronal third to be removed.

Selecting the Correct RECIPROC® Instrument

In most cases, the R25 will be suitable in size for the root canal treatment. Consult the pre-operative radiograph to see if the canal is likely to be considered as narrow, medium or wide:

If the canal is partially or completely invisible on the radiograph: The canal is considered narrow; use an R25. If the canal is completely visible on the radiograph: Take an ISO size 30 hand instrument; insert it passively into the canal. If it reaches working length, the canal is considered large; use the R50. If an ISO size 30 hand instrument does not go passively to working length, try an ISO size 20 hand instrument. If this goes passively to working length, the canal is considered medium; use the R40. If an ISO size 20 hand instrument does not go passively to working length, use the R25.

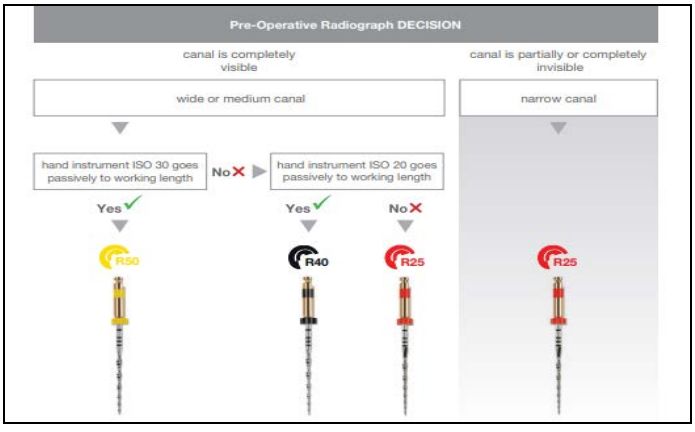


Fig. 18

Preparation Step by Step

Estimate or determine the root canal length depending on whether it is a narrow, medium or wide canal

Fig. 19

1. Place irrigant in the access cavity of the root canal.
2. Select the appropriate RECIPROC® instrument and secure it in the handpiece of the VDW RECIPROC® motor
3. Check that the RECIPROC® motor setting has been selected.

Fig .20

Introduce the RECIPROC® instrument into the canal. Press the motor foot pedal when the instrument is at the root canal orifice

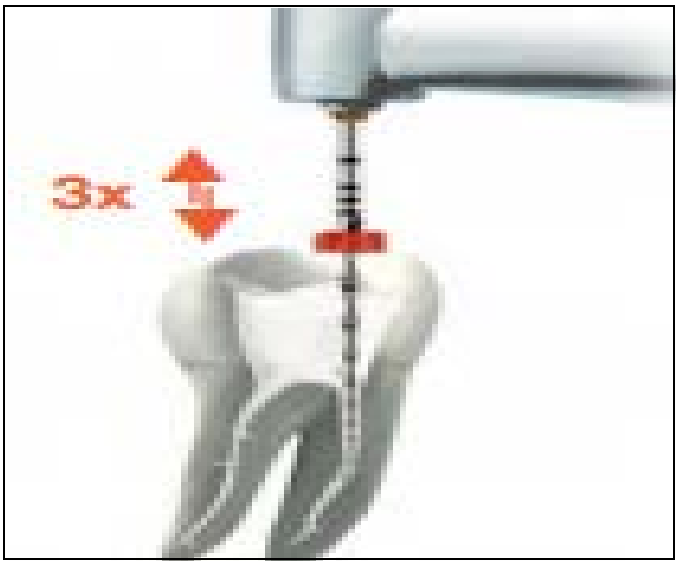


Fig. 21

Move the instrument in a slow in-and-out pecking motion. The amplitude of the in-and-out movements should not exceed 3 mm. Only very light pressure should be applied. The instrument will advance easily in the canal. 1 in-andout movement = 1 peck

Fig.22

After 3 pecks, remove the instrument from the canal. Clean the debris from the flutes in the Interim Stand.

Fig.1.23

Irrigate the canal.

Fig.1.24

Make sure the canal is free to approx. 3 mm beyond the prepared canal section with an ISO size 10 C-PILOT® File.

In this way, continue with the RECIPROC® instrument until approx. 2/3 of the working length has been reached. When using an R25: determine the working length by using an ISO size

C-PILOT® File . When using an R40 or R50: the working length should be re-checked with an apex locator . Continue with the RECIPROC® instrument until full working length has been reached.

As soon as full working length has been reached, withdraw the instrument from the root canal.

Retreatment of gutta-percha obturations

Gutta-percha filling material can be removed from the root canal with the RECIPROC® R25.

Remove the bulk of the gutta-percha in the coronal third of the canal with an appropriate instrument, e.g. a Gates Glidden drill, or an ultrasonic instrument such as VDW.ULTRA®. Depending on the consistency of the gutta-percha it is possible to start the retreatment directly with R25.

Use a drop of solvent (e.g. eucalyptus oil) as required

Use R25 as described until working length has been reached. If resistance is encountered, do not apply pressure. Remove the instrument from the canal, re-apply solvent and try again.

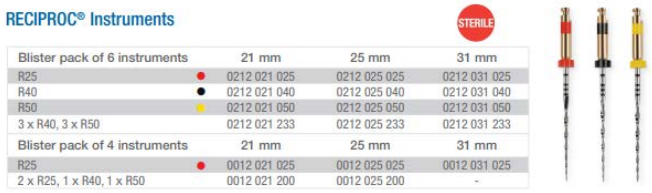
Use a brushing motion against lateral walls to remove residual obturation material.

After reaching working length with R25, use R40 or R50 for an increased apical enlargement, as necessary.

Retreatment of carrier-based obturators

Proceed as described in points 1. to 5. above. The carrier may be removed in one piece during the use of the RECIPROC® instrument; otherwise, it will be removed in small pieces with the gutta-percha.

RECIPROC® Product Range



RECIPROC® Instruments

Blister pack of 6 instruments	21 mm	25 mm	31 mm
R25	0212 021 025	0212 025 025	0212 031 025
R40	0212 021 040	0212 025 040	0212 031 040
R50	0212 021 050	0212 025 050	0212 031 050
3 x R40, 3 x R50	0212 021 233	0212 025 233	0212 031 233
Blister pack of 4 instruments	**21 mm**	**25 mm**	**31 mm**
R25	0012 021 025	0012 025 025	0012 031 025
2 x R25, 1 x R40, 1 x R50	0012 021 200	0012 025 200	-

Fig. 25

RECIPROC BLUE (2016)[14]

The new RECIPROC® blue file generation combines the ease of the original RECIPROC one file endo concept with enhanced safety in root canal preparation and retreatment for patients. An innovative heat treatment makes RECIPROC blue particularly flexible to ensure a smoother and safer progression in the canal.

RECIPROC blue files are produced with Nickel- Titanium (NiTi) that goes through an innovative heat treatment, modifying its molecular structure to give it increased resistance to cyclic fatigue and additional flexibility as well as its characteristic blue color.

The shape obtained by the RECIPROC blue instrument enables effective irrigation and obturation with both cold and warm techniques.

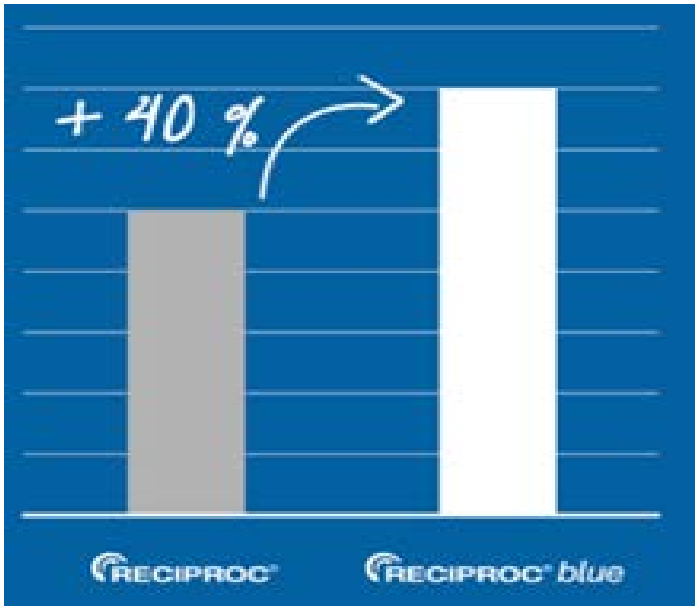


Fig. 26 : Increased Flexibility

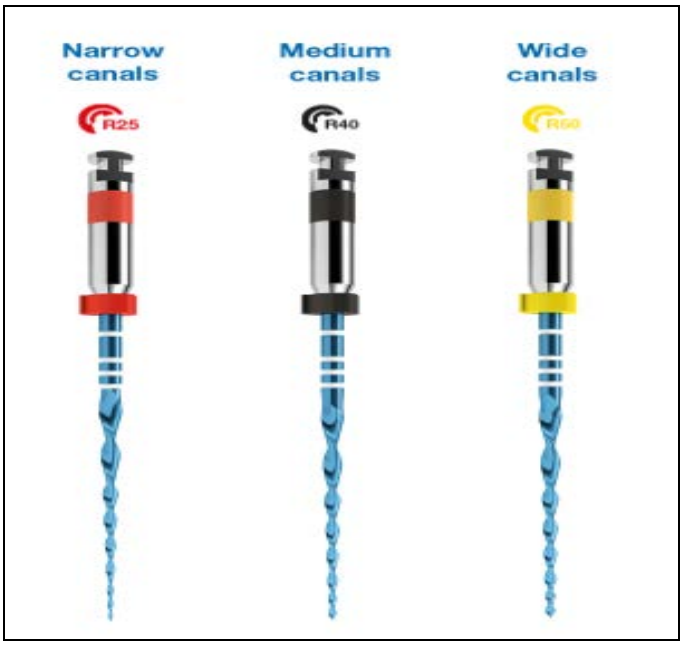


Fig. 27

RECIPROC® blue instruments RECIPROC® blue is designed to be used as a single instrument. That means that one instrument only is required to prepare a root canal. One RECIPROC® blue instrument does the job of several instruments which would need to be used for preparation with regular hand or continuous rotary instruments. The shape obtained by the RECIPROC® blue instrument enables effective irrigation and obturation with both cold and warm techniques.

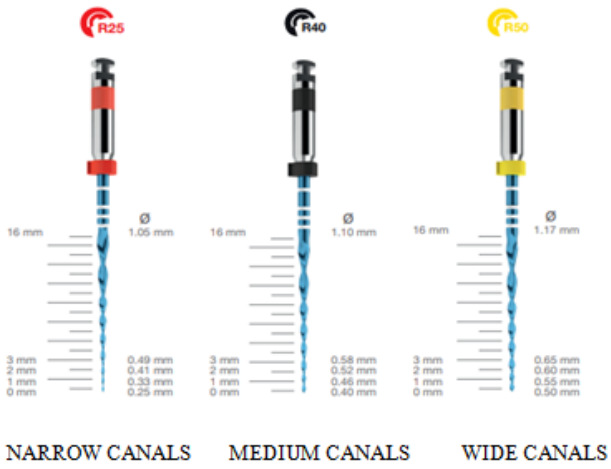


Fig. 28

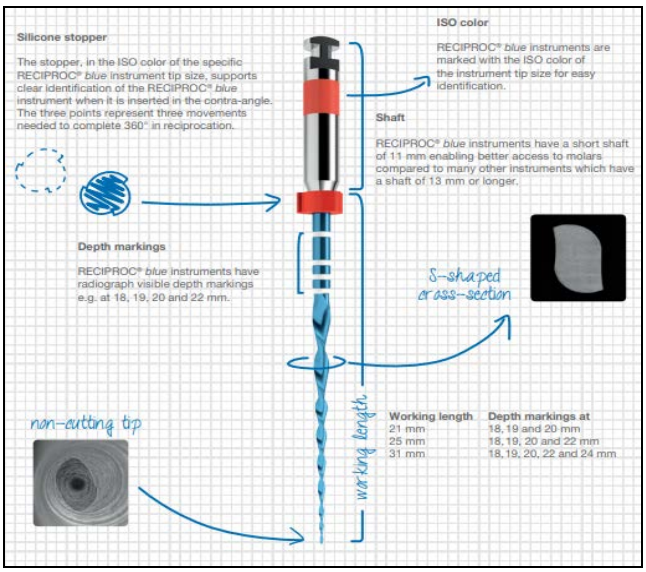


Fig. 29

RECIPROC® blue instruments have been specifically designed for use in reciprocation. The perfect combination between our specific s-shaped cross section, the variable taper, the cutting angles and the thermally improved raw material provides high efficiency and cutting performance. The file's tip is non-cutting for a gentle treatment near the apex.

The improved NiTi alloy RECIPROC® blue files are produced with NickelTitanium (NiTi) that goes through an innovative heat treatment, modifying its molecular structure to give it increased resistance to cyclic fatigue and additional flexibility as well as its characteristic blue color.

Conclusions

The clinical technique in which reciprocating instruments like WaveOne and Reciproc are used can play a vital role in the successful outcome of the cleaning and preparation phase of endodontic treatment. Most studies agree that the reciprocating movement can reduce torsional (binding to dentine is reduced) and flexural stresses (number of rotation cycles are reduced) on endodontic instruments. These instruments also maintain the original canal

anatomy and demonstrate reduced time for canal preparation compared with full rotary systems. However, there are conflicting results in the literature regarding the efficacy of debris removal and bacterial reduction and there remains the possibility of debris extrusion and dentinal crack formation during root canal preparation with reciprocating instruments.

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