

Canal preparation using one reciprocating instrument without prior hand filing: A new concept

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Introduction

Effective cleaning and shaping of the root canal system is essential for achieving the biological and mechanical objectives of root canal treatment (Sjögren et al. 1997). The objectives are to remove all the pulp tissue, bacteria and their by-products while providing adequate canal shape to fill the canal.

Traditionally, the shaping of root canals was achieved by the use of stainless steel hand files. However, techniques using stainless steel hand files have several drawbacks:

They require the use of numerous hand files and drills to adequately prepare the canals (Schilder 1974).

Hand instrumentation with stainless steel files is time consuming (Ferraz et al. 2001).

The stainless steel hand instrumentation techniques have an increased incidence of canal transportation (Kuhn et al. 1997, Reddy & Hicks 1998, Ferraz et al. 2001, Pettiette et al. 2001).

Finally, from a clinical standpoint, the use of hand instruments in narrow canals can be very frustrating especially in teeth with difficult access.

Nickel-titanium (NiTi) hand or rotary instruments are also used to achieve the mechanical objectives of the canal preparation. The (NiTi) instruments offer many advantages over conventional stainless steel files. They are flexible (Walia et al. 1988), have increased cutting efficiency (Kazemi et al. 1996) and have improved time efficiency (Ferraz et al. 2001). Furthermore, NiTi instruments maintain the original canal shape during preparation and have a reduced tendency to transport the apical foramen (Kuhn et al. 1997, Reddy & Hicks 1998, Ferraz et al. 2001, Pettiette et al. 2001).

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However, as these techniques also require the use of numerous instruments to enlarge the canal to an adequate size and taper, they are relatively time consuming. Also, the use of hand instruments (for example to create a glide path prior to using a rotary instrument), which can be very frustrating in narrow canals in teeth with a limited access, is required.

The purpose of this article is to introduce a new concept for canal preparation, a paradigm shift. The canal preparation is accomplished using only one nickel-titanium engine-driven instrument used in reciprocation and without prior hand filing, which means hand files are not used to enlarge the canal prior to using the reciprocating file.

This new concept is a paradigm shift because it goes completely against the current teaching standard, which requires the gradual enlargement of the canal with different files / instruments until the desired shape is obtained. Only one instrument, the reciprocating instrument, is needed to enlarge the canal, even a narrow and curved canal, to an adequate size and taper. However, there are some exceptions that will be discussed later in this article.

This new concept is also a paradigm shift because it goes completely against the current teaching standard, which requires the creation of a glide path with smaller instruments prior to using a shaping instrument to minimize the incidence of fracture. A glide path is no longer a pre-requisite with this new concept of canal preparation. This article also introduces the notion of the "*path of least resistance*". The shaping instrument will follow the existing and natural path of least resistance, which is the canal. This is not only time-saving but also particularly convenient in teeth with limited access. Additionally, errors associated with the use of hand filing prior to using mechanically driven instruments can be avoided.



Figure 1: R25 (red), R40 (black), R50 (yellow).



Figure 2: RECIPROC Paper Points.



Figure 2: RECIPROC Gutta-Percha.

The first and only paper on the use of only one engine-driven instrument in reciprocation to prepare a root canal was published in the International Endodontic Journal (Yared 2008). The article described the use of an F2 ProTaper instrument. However, the use of that instrument in reciprocation presented 2 drawbacks:

Instrument fracture by cyclic fatigue in relation to the relative rigidity of the instrument due to its size, taper and cross-section (Pruett 1997).

The necessity of creating a glide path with additional hand files prior to using the F2 instrument in reciprocation. The clinical impression was that the F2 instrument does not cut efficiently enough into a narrow and uninstrumented canal. Frequently, it does not advance in the canal without a glide path.

Other rotary instruments were also tested in a single file preparation technique. Issues similar to those encountered with the use of the F2 were observed.

An ATR Vision motor (ATR, Pistoia, Italy) was used with the F2. This motor is no longer manufactured.

For these reasons, a new system for single file reciprocation without prior use of hand files was developed (VDW GmbH, Munich, Germany). The system includes 3 instruments, the RECIPROC instruments (R25, R40 and R50) (Figure 1), a motor (VDW SILVER RECIPROC) (Figure 5), matching paper points (Figure 2) and gutta-percha cones (Figure 3). Only one RECIPROC instrument is used for the canal preparation depending on the initial size of the canal.

The instruments are made from an M-Wire nickel-titanium which offers greater flexibility

and resistance to cyclic fatigue than traditional nickel-titanium. They have an S-shaped cross section (Figure 4). The three instruments have a regressive taper.

The R25 has a diameter of 0.25 mm at the tip and an 8% (0.08 mm / mm) taper over the first 3 mm from the tip. The diameter at D16 is 1.05 mm.

The R40 has a diameter of 0.40 mm at the tip and a 6% (0.06 mm / mm) taper over the first 3 mm from the tip. The diameter at D16 is 1.10 mm.

The R50 has a diameter of 0.50 mm at the tip and a 5% (0.05 mm / mm) taper over the first 3 mm from the tip. The diameter at D16 is 1.17 mm.

The motor is battery operated. The battery is rechargeable and the motor can be used while the battery is charging. The instruments are used at 10 cycles of reciprocation per second, the equivalent of approximately 300 rpm. The motor is programmed with the angles of reciprocation and speed for the 3 instruments. The values of the CW and

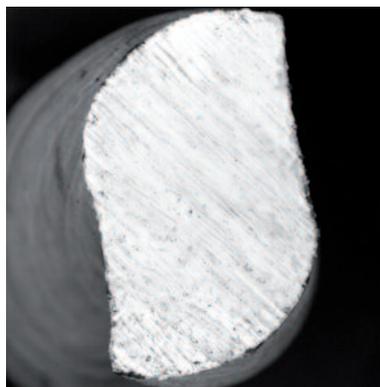


Figure 4: RECIPROC cross-section.



Figure 5: VDW SILVER® RECIPROC®

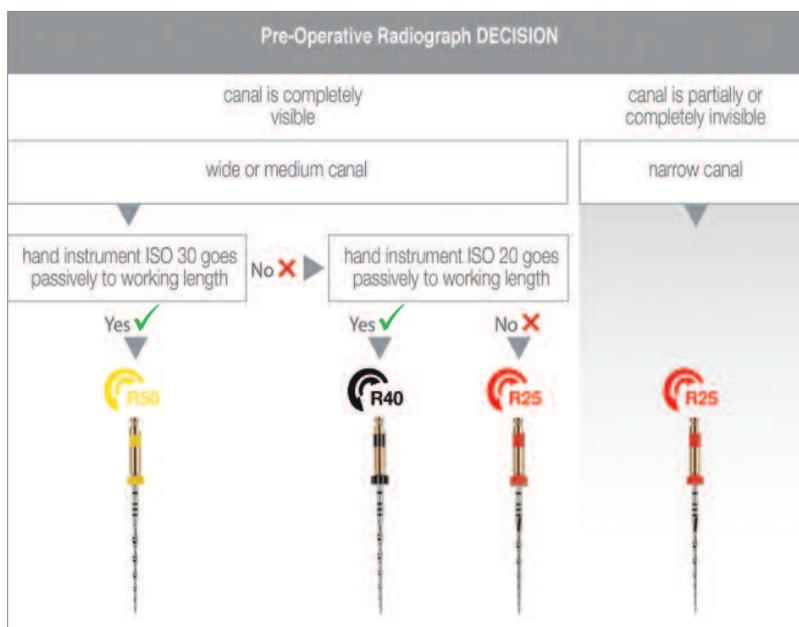


Figure 6: Selection of the appropriate RECIPROC® instrument.

CCW rotations are different. When the instrument rotates in the cutting direction it will advance in the canal and engage dentine to cut it. When it rotates in the opposite direction (smaller rotation) the instrument will be immediately disengaged. The end result, related to the degree of CW and CCW rotations, is an advancement of the instrument in the canal. Consequently, only very light apical pressure should be applied on the instrument as its advancement would be almost automatic. These angles are specific to the RECIPROC instruments. They were determined using the torsional properties of the instruments and are influenced by specific features related to the motor such as torque. Therefore, the use of other instruments with those angles and motor, and the use of other reciprocating

handpieces / motors may lead to instrument fracture.

Technique

The technique is extremely simple. In the majority of canals, only one RECIPROC instrument is used in reciprocation to complete the canal preparation and there is no need for hand filing.

The access cavity requirements, the straight-line access to the canals and the irrigation protocol are the same as for standard preparation techniques. It is not necessary to widen the root canal orifice with a Gates Glidden drill or an orifice opener.

Selection of the appropriate RECIPROC instrument (Figure 6)

Selection of the RECIPROC instrument is based on an adequate pre-operative radiograph. If the canal is partially or completely invisible on the radiograph, the canal is considered narrow and the R25 is selected (Figure7). In the other cases, where the radiograph shows the canal clearly from the access cavity to the apex, the canal is considered medium or wide (Figure8). A size 30 hand instrument is inserted passively (with a gentle watch winding movement but without filing action) to the working length. If it reaches the working length, the canal is considered large; the R50 is selected for the canal preparation. If the size 30 hand file does not go passively to working length, a size 20 hand file is inserted passively to the working length. If it reaches

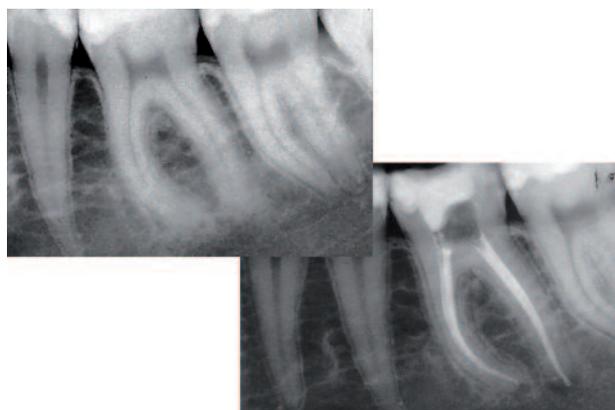


Figure 7: Canal is considered narrow: R25.

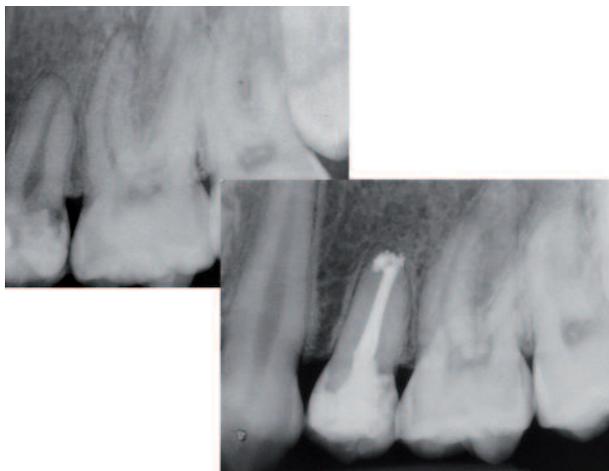


Figure 8: Canal clearly visible from access cavity to apex: considered medium or wide (R50 was used for the canal preparation; an increased apical enlargement was obtained with a size 70 hand file).

working length, the canal is considered medium; the R40 is then selected for the canal preparation. If the size 20 hand instrument does not reach the working length passively, the R25 is selected.

Preparation step by step (without creating a glide path)

In reciprocation, clockwise and counterclockwise angles determine the amplitude of reciprocation, the right and left rotations. These angles are lower than the angles at which the RECIPROC instrument would usually fracture (if bound). When a reciprocating file binds in the canal, it will not rotate past its specific angle of fracture. Therefore, the creation of a glide path to minimize binding is not required for the RECIPROC instruments. The cutting efficiency of the RECIPROC instruments and the centering ability associated with reciprocation allow the instruments to enlarge uninstrumented and narrow canals in a safe manner.

Before commencing preparation, the length of the root canal is estimated with the help of an adequately exposed

and angulated pre-operative radiograph. The silicone stopper is set on the RECIPROC instrument at 2/3 of that length. The RECIPROC instrument is introduced in the canal with a slow in-and-out pecking motion without pulling the instrument completely out of the canal. The amplitude of the in- and out- movements should not exceed 3-4 mm. Only very light pressure should be applied. The instrument will advance easily in the canal in an apical direction. After 3 in- and out- movements, or when more pressure is needed to make the instrument advance further in the canal, or when resistance is encountered, the instrument is pulled out of the canal to clean the flutes. A # 10 file is used to check patency to 2/3 of the estimated working length. The canal is copiously irrigated.

The RECIPROC instrument is used until it has reached 2/3 of the estimated working length as indicated by the stopper on the instrument. The instrument is then removed from the canal, the canal is irrigated and a #10 file is used to determine the length. The RECIPROC instrument is then re-used in the same manner until the working length has been reached. As soon as the working length has been reached, the RECIPROC instrument is withdrawn from the canal. The RECIPROC instrument can also be used in a brushing motion against the lateral walls of wide canals.

Creating a glide path during the use of the RECIPROC instruments: indication and management (Figure 9)

With continuous rotary NiTi systems it is necessary to create a glide path in order to minimize the risk of fracture (Peters et al. 2003, Yared et al. 2004, Patino et al. 2005). During the use of a rotary instrument, the tip of the instrument may bind in the canal. The motor will keep rotating the instrument while the tip of the instrument is bound. The instrument will rotate past its plastic limit and will eventually fracture at a specific angle of rotation. For this reason, it is necessary to create an initial glide path, or a minimal canal enlargement, before using continuous rotary instruments. The glide path will minimize the incidence of instrument



Figure 9: Glide path was created for the DB canal.



Figure 10: Abrupt apical curvature.

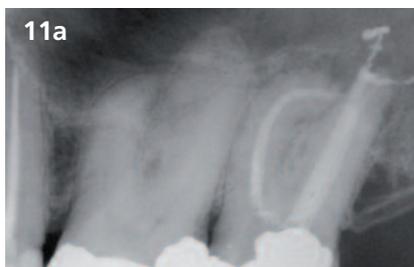


Figure 11: Gradual curvature. Size 10 file used for the working length determination will reach working length without being pre-curved.

binding and, therefore, minimizes the risk of fracture.

Just as with any continuous rotary NiTi system, it is also possible to use the RECIPROC reciprocating file after creating an initial glide path with hand instruments to a size 10 or 15.

A glide path may also have to be created in some canals when the RECIPROC instrument stops advancing in the canal or if advancement becomes difficult. In this case, pressure should not be exerted on the RECIPROC instrument. The instrument should be removed from the canal, and the canal irrigated. If the RECIPROC instrument still advances with difficulty or if it does not advance, it should be removed from the canal and the canal irrigated once again. At this point, hand files # 10 and 15 should be used to create a glide path to the working length. The RECIPROC instrument would then be used until the working length has been reached. If, however, the progress of the RECIPROC instrument is still difficult or not possible, the canal preparation would need to be completed with hand files.

Using hand files to finish the apical canal preparation

In some canals, the #10 file used for the working length determination (after the RECIPROC instrument has reached 2/3 of the estimated working length) has to be pre-curved, otherwise it cannot reach working length. This indicates the presence of an abrupt apical curvature (Figure 10). The use of the RECIPROC instruments is contra-indicated in this instance. The canal preparation has to be finished with hand files. However, in most of the cases, the size 10 file used for the working length determination will reach that length without being pre-curved (indicating the presence of a gradual curvature) (Figure 11). The RECIPROC will be used to working length to complete the preparation.

Increased apical enlargement (Figure 8)

In some canals an increased apical enlargement (based on

gauging the canal, for example) may be required. A larger RECIPROC instrument or a hand instrument may be used for this purpose following the R25 and the R40, and a hand instrument is used following the R50.

Additional advantages of the RECIPROC concept and instruments

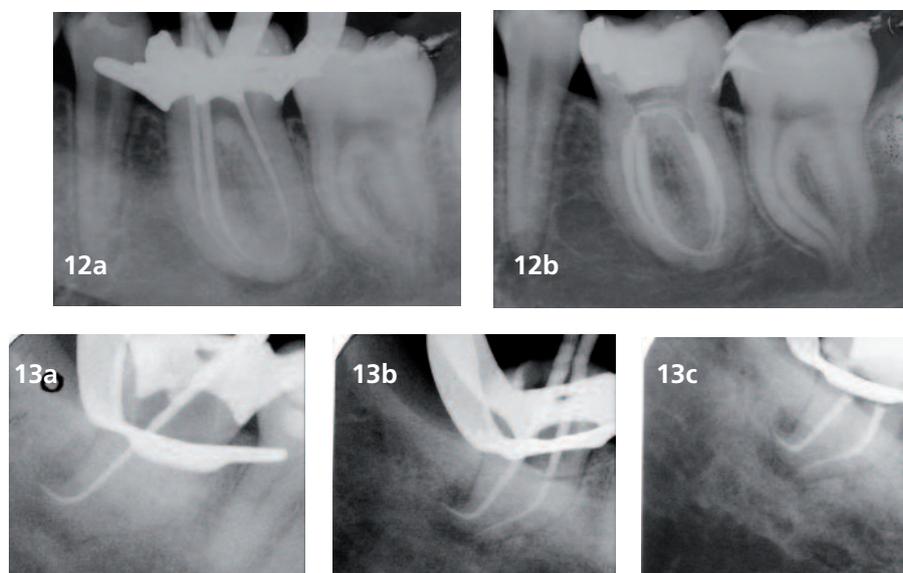
Centring ability

Preliminary evidence has demonstrated the centring ability of the reciprocating instruments used according to this concept (S. Kuttler, unpublished results). Figures 12 and 13 show severely curved canals prepared with the R25 without the creation of a glide path. The radiographs show that the canal curvature was maintained despite the severity of the curvature.

Safety

A rotary instrument can also fracture if it binds in the canal, especially at its tip. When using a rotary system the tip of the instrument may bind in the canal; the motor will keep rotating the instrument while its tip is bound and the instrument will eventually fracture at a specific angle of rotation. In reciprocation, clockwise and counterclockwise angles determine the amplitude of reciprocation, the right and left rotations. These angles, stored in the motor, are significantly lower than the angles at which the instrument would usually fracture. If the instrument binds in the canal, it will not fracture because it will never reach the angle at fracture. In this respect, single file reciprocation is safer than rotary techniques because fracture by binding (fracture by taper lock or torsional fracture) is eliminated.

One RECIPROC instrument replaces several hand and / or rotary instruments for a canal preparation procedure. Therefore, the RECIPROC instrument is subjected to cyclic fatigue and should be discarded after the completion of a case. The plastic band on the handle of the instrument



Figures 12 and 13: Severely curved canals prepared with the R25 without the creation of a glide path.

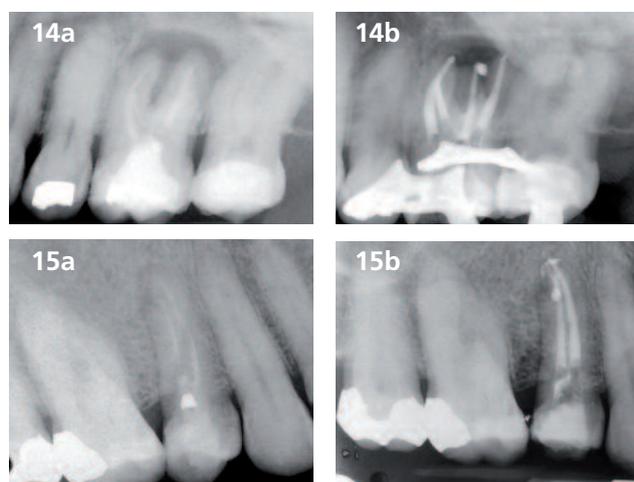
deforms if the instrument is autoclaved; this safety feature eliminates fatigue fracture due to repeated use in more than one case.

Shorter working time

Working time was 4 times faster with the single file reciprocation in comparison with a NiTi rotary preparation technique (unpublished results).

Faster learning

92% of RECIPROC users were able to prepare 3 canals consecutively without errors compared to 30% of the continuous rotary NiTi system users (unpublished results).



Figures 14 and 15: Retreatment of gutta-percha obturations.

Less procedural errors

A lower incidence of complications such as canal transportation, ledging and blockage was observed with the single reciprocation technique than with a major rotary technique (unpublished results).

Elimination of cross contamination between patients

The clinician is faced with a major concern when considering the use of NiTi rotary instruments: the possibility of cross-contamination associated with the inability to adequately clean and sterilize endodontic instruments (Spongiform Encephalopathy Advisory Committee 2006). A recent study found prions in human pulp tissue (Schneider et al. 2007). Tooth structure and organic debris were observed on the surface of NiTi rotary instruments, and appeared to adhere in the surface cracks despite meticulous ultrasonic cleaning and decontamination (Alapati et al. 2003, 2004, Sonntag & Peters 2007). Therefore, the single use of endodontic instruments was recommended to reduce instrument fatigue and possible cross-contamination. However, the single use of endodontic instruments and, mainly the more expensive NiTi rotary instruments, may become an economical burden on the endodontist and the general dentist especially as the available techniques involve the use of at least three to four NiTi rotary instruments. Consequently, the introduction of this new concept for the canal preparation technique which reduces the number of instruments required to achieve the mechanical and biological objectives is beneficial. The instrument is discarded after each case; cross-contamination among

patients is eliminated and cross-contamination involving the staff is minimized because the assistant(s) will discard the instrument immediately after completing the case instead of manipulating the instrument to clean it.

Retreatment of gutta-percha obturations

(Figures 14 and 15)

Gutta-percha filling material can be easily removed from the canal with the RECIPROC 25. First of all, the bulk of the gutta-percha in the coronal third of the canal should be removed with an appropriate instrument (e.g. electric heat carrier, ultrasonic tip). A solvent (e.g. eucalyptus oil) is used as required and the R25 is used as described above until working length has been reached. If resistance is encountered, pressure should not be applied. The instrument should be removed from the canal, the solvent replaced and the R25 used again.

After reaching working length with the R25, the R40 or R50 can be used for an increased apical enlargement, as necessary. RECIPROC instruments can also be used in a brushing motion against the lateral walls of the canal to remove any residual filling material

Retreatment of carrier-based obturators

Carrier-based obturators can be removed in the same manner as gutta-percha filling material. 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.

Disclosure

Dr. Ghassan Yared is the inventor of single file reciprocation and was involved in the development, field testing and research of RECIPROC.

References

References are available on request