

# WaveOne Gold Reciprocating Instruments in Clinical Practice (Part 1)

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## Abstract:

The design features of the WaveOne Gold Primary system and some of its previous analogs will be discussed since they allow channel processing using only one file in 80-85% of clinical cases. In the second part of the article, we will discuss when it is still necessary to use more than one WaveOne Gold instrument with examples of specific complex clinical cases with curved canals. In the end, we will pay attention to the peculiarities of processing very large canals, which are also difficult for the doctor.

**Keywords:** endodontic instruments, WaveOne Gold, reciprocal instruments.

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## INTRODUCTION

The WaveOne NiTi Nickel-Titanium File System was first introduced to the dental market in 2011 (Figure 1). It was a pre-packaged and pro-sterilized set of endodontic instruments that ensured proper preparation of the root canal system with the formation of their desired tapered shape [1]. Then the manufacturer introduced a new generation of reciprocal analogues WaveOne Gold, which are characterized by even greater ease of use and improved clinical efficacy.

### Why return or reciprocal movements?

When working in the root canals with ordinary nickel-titanium files, they are susceptible to some stress, which reduces their strength, and with repeated manipulations can lead to fracture of the tool. Torsional resistance and structural fatigue are the two main causes of clinical failure in terms of instrument performance [2].

Fractures during file twisting occur when the tip of the instrument gets stuck in the dentin of the root, and the rest continues its circular moment. A fracture due to structural bending fatigue (bending stress) develops when an already weakened metal tool is subjected to additional stress. In such cases, the fracture is not due to tip sticking in dentin, but due to reaching the point of maximum bending [3]. Flexural stress, therefore, depends on the anatomy of the root canal, and it is logical that it is significantly higher in more curved endodontic spaces [4]. In 2008, Yared conducted the first study on the variable (reciprocating) movements of an endodontic working instrument, using the ProTaper F2 (Dentsply Sirona) [5]. In theory, this approach, with a change in the direction of file rotation, reduces the number of work cycles and, consequently, cyclic fatigue, compared to constantly working the file in one direction [6]. In addition, the study has shown that fewer instruments are required for sequential processing of the endodontic space, which also minimizes the risk of excessive canal contamination and the risk of potential file fracture [5]. All of these factors also help to reduce endospace processing time, which has important economic implications. These

results were confirmed in subsequent studies by Burklein and Schäfer in 2012, which compared the Reciproc (VDW) and WaveOne (Dentsply Sirona) reciprocating systems with Mtwo (VDW) and ProTaper, which were used with a standard protocol [7].

### Reciprocal movements: the essence

The principle of reciprocal movement is that, instead of just rotary movement, the files operate in a reverse "balanced force" mode [8], which is provided by a preprogrammed motor (X-Smart Plus equipped with a 6:1 reduction handpiece) or the new X-Smart iQ endodontic system with an 8:1 that is able to rotate files back and forth in a "reciprocating" motion. A counterclockwise (CCW) movement of 150 degrees is capable of apical advancement of the instrument, cutting dentin from the root canal wall. This movement is followed by the opposite movement – 30 degrees clockwise (CW), which ensures that the tool tip does not get stuck until the maximum torsional tension is reached. Three successive cycles of reciprocating motion complete one full backward rotation (CCW), and the repeated cutting and release of the instrument in the dentin tissue propels the instrument into the canal [9].

The irregular CW / CCW reciprocating motion of WaveOne Gold systems has the following advantages over continuous rotation systems:

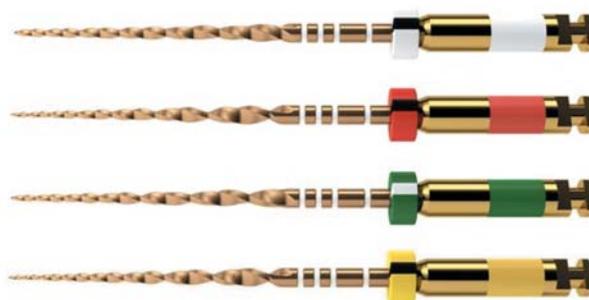


Fig. 1. WaveOne NiTi Nickel-Titanium File System.

- The instrument gets stuck in the dentin of the root canal wall much less frequently, which reduces the torsional stress of the instrument [6]
- Reducing the number of working cycles in the root canal during its preparation leads to the development of less bending stress in the structure of the instrument [3]
- Since the CCW release angle is less than the elastic limit of the tool, this ratio provides greater tool safety [10]
- Reduced risk of tool fracture [6]
- All of the above factors allow the file to move easily along the required working length without applying excessive, potentially harmful internal pressure to the instrument [10]
- Such an algorithm of movements also provides opportunities for removing the formed scrapes from the cavity of the endospace during its preparation [10]

Features of metallurgical production and tool design  
The classic WaveOne system was manufactured using M-Wire technology. M-Wire is provided by a dedicated thermal process that aims to increase the flexibility and resilience of the file to cyclic stress. WaveOne Gold tools are manufactured by additional heat treatment after production, as a result of which it is possible to identify a new point between the transition from the state of martensite to austenite, which, in turn, allows to obtain similar superelastic properties. WaveOne Gold files are 50% more resistant to cyclic fatigue, 80% more flexible and 23% more efficient than the classic WaveOne system [10]. Due to the superelastic properties of the new gold core, the file may appear slightly curved when removed from a curved root canal, but only because the metal exhibits less shape memory compared to conventional nickel titanium or M-Wire (Figure 2).

The file can be straightened, and when it is placed in the root canal again, it follows the natural shape of the endospace that is already familiar to it [11]. Other advantages of this reduced shape memory are that in cases where direct access is difficult, the file can be slightly pre-prepared to ensure that it fits comfortably into the channel openings.

Classic WaveOne instruments were characterized by a variety of cross-sectional designs along the entire working length: at the tip – round, in the middle part and near the top – from the shape of a modified triangular / convex shape to a triangle with a zero rake / convex cross section.

WaveOne Gold files are characterized by a parallelogram shape (with two cutting edges at 85 degrees) with an off-center cross-section [11]. According to Ruddle, this design limits the interaction between file and dentin to only one or two contact points for any cross-sectional shape. This subsequently reduces the risk of cone and screw locking effects, which in turn improves the safety and efficiency of root dentin treatment and provides more space around the instrument for coronal deburring.



**Fig. 2. Due to its super elastic properties, the WaveOne Gold file may appear slightly curved when removed from a curved root canal, but only because the metal exhibits less shape memory compared to conventional nickel titanium or M-Wire.**

The new files are also characterized by a rounded-tapered and semi-active guiding tip of the ogival shape, which also ensures a reliable passage of the file along the canal wall along a certain trajectory [10,11]

The WaveOne Gold Endodontic System is available in four different tip file sizes 21 mm, 25 mm and 31 mm:

1. WaveOne Gold Small File (yellow ring). The top of the file is ISO 20, and the first 3 mm of the file (D1-D3) has a continuous tapered shape of 7%.
2. WaveOne Gold Primary File (red ring). The file has a top size of ISO 25 and the first 3 mm of the file (D1-D3) has a continuous tapered shape of 7%.
3. WaveOne Gold Medium File (green ring). The file tip size is ISO 35, and the first 3 mm of the file (D1-D3) has a continuous tapered shape of 6%.
4. WaveOne Gold Medium File (white ring). The file tip size is ISO 45 and the first 3 mm of the file (D1-D3) has a continuous tapered shape of 5%.

#### Clinical Practice Guidelines for WaveOne Gold Instruments

1. Provide adequate access. It is always important to prepare an adequate access cavity to provide a straight path to the endospace after pulp tissue removal. Ultrasound systems are effective in cases of pulp calcification and modification of the access cavity walls. Considering that WaveOne Gold has even less shape memory than conventional NiTi or M-Wire instruments, slight bending of the file tip can be made in order to facilitate access to the endodontic space.
2. Choosing the correct WaveOne Gold file The following guidelines can be used to select a WaveOne Gold file.
  - a. WaveOne Gold Primary File (25/07). Any canal for which K-files of sizes 08 and 10 are used must be developed to the working length, after which a carpet path is formed or such a trajectory on which the file of size 15 would feel free along the entire working length. This algorithm is suitable for most root canal systems with average lengths and average bends in the mid- or apex area.
  - b. WaveOne Gold Medium file (35/06). Any channel in which K-files of size 20 or 25 feel free does not require additional processing with smaller instruments. This is observed with larger root canals and with a predominantly straight path. This type of instrument can also be used after the primary file to achieve the desired canal shape, or at the risk of insufficient preliminary cleaning of the endospace
  - c. WaveOne Gold Large file (45/05). Any channel in which 30 or 35 K-files feel free does not require further processing with smaller instruments. This is observed with larger root canals and with a predominantly straight path. This file can also be used after medium-sized files to recreate the desired shape, or if there is a risk of insufficient preliminary cleaning of the endospace.
  - d. WaveOne Gold Small file (20/07) (photo 2) WaveOne Gold Small file is mainly used when the primary file of 25/07 cannot passively penetrate to the apical end, or in cases where the physician does not feel very confident after processing the endospace with the primary file. When all working lengths are reached with the WaveOne Gold Small file, the clinician can further modify the canal shape or enlarge its size

using the 25/07 instrument. Thus, WaveOne Gold Small can be considered as a transitional instrument between small and primary instruments for the treatment of endodontic spaces [10].

However, in canals with complex apical curves or long canals, WaveOne Gold Small can be used as a primary preparation, ensuring proper surgical safety. When this file reaches the working length, the clinician can stop at this stage of processing, or modify it using larger files like 25/07.

#### **Clinical Protocol for Canal Preparation Using Primary WaveOne Gold File**

When choosing the Primary WaveOne Gold instrument, the canal should usually be developed with files 08 and 10 along the entire working length, followed by preparation of the carpet until the K-file 15 can reach this working length. To form a proper carpet, the authors recommend the following algorithm.

After evaluating the working length according to the X-ray image, the patency of the canal is assessed with instruments of size 08 or 10 using a viscous chelating agent. After determining the parameters of the channel patency, its working length is checked and a micro-carpet path is formed using stainless steel tools [1].

It is recommended to use K-files of size 08 or 10 with vertical movements "back and forth" and an amplitude of 1 mm from the working length indicator. The amplitude increases over time to about 4 mm as the irregularities of the channel are smoothed out during processing [1]. The minimum preparation requirement is to achieve free canal parameters for a file size of 10 [1]. To confirm patency, a 10 K-file is inserted over the full working length of the canal. The file is retracted 1 mm from the apical constriction and it is checked whether it can reach the same insertion depth with only a slight movement of the doctor's finger. Similarly, the quality of the carpet is checked, taking the tool 2 mm from the working length indicator. When confirming the protocol, when the file is removed by 4-5 mm, it can be argued that there is an adequate micro-carpet path. Only after this stage, they begin to form an enlarged carpet. For this purpose, either ProGlider (Dentsply Sirona) or WaveOne Gold Glider (Dentsply Sirona) is used.

ProGlider is an ISO size 16 tip 2% taper rotary M-Wire tool. The taper then gradually increases to 8.5% per 18 mm active cutting groove. The WaveOne Gold Glider works in a reciprocating manner and features a 15 ISO tip and a 2% taper with a gold core.

Canal Preparation Using Primary WaveOne Gold File This type of instrument helps to ensure safe endospace machining, reducing the risk of instrument strain and evacuation of debris into the apical space, without compromising the cutting efficiency of the file. After the formation of the carpet path, the primary file is inserted into the buccal or palatal canal and the initial depth of penetration of the instrument is recorded, using a rubber stopper and the tip of the tooth tuber as a control point. After that, the instrument is removed and a similar procedure is carried out in the other canal, determining the average value between the two canals. Then the rubber stopper is moved to a working length 4-6 mm longer than the initial data for recording the length of the canal. In the presence of an irrigation solution (sodium hypochlorite (NaOCl)), the primary file can passively pass into the canal under the action of the reciprocating movements of the tip. The sweeping movements are used only in canals with

uneven morphology or to remove some irregularities in the endospace. The purpose of the first passage of the canal is only is to cut a path to the apical root until the rubber stopper reaches the control point – this way the doctor knows that it is time to remove the instrument and clean it of debris. After that it is important to check the condition of all cutting areas tool before reuse.

After cleaning the file, the preparation of the prepared endospace in another canal is started according to the same protocol. For complete cleaning of the canal, an additional irrigation solution (NaOCl) is used with the parallel use of K-files of size 08 or 10 according to the technique of winding the watch (for recapitulation), after which a repeated irrigation treatment is carried out.

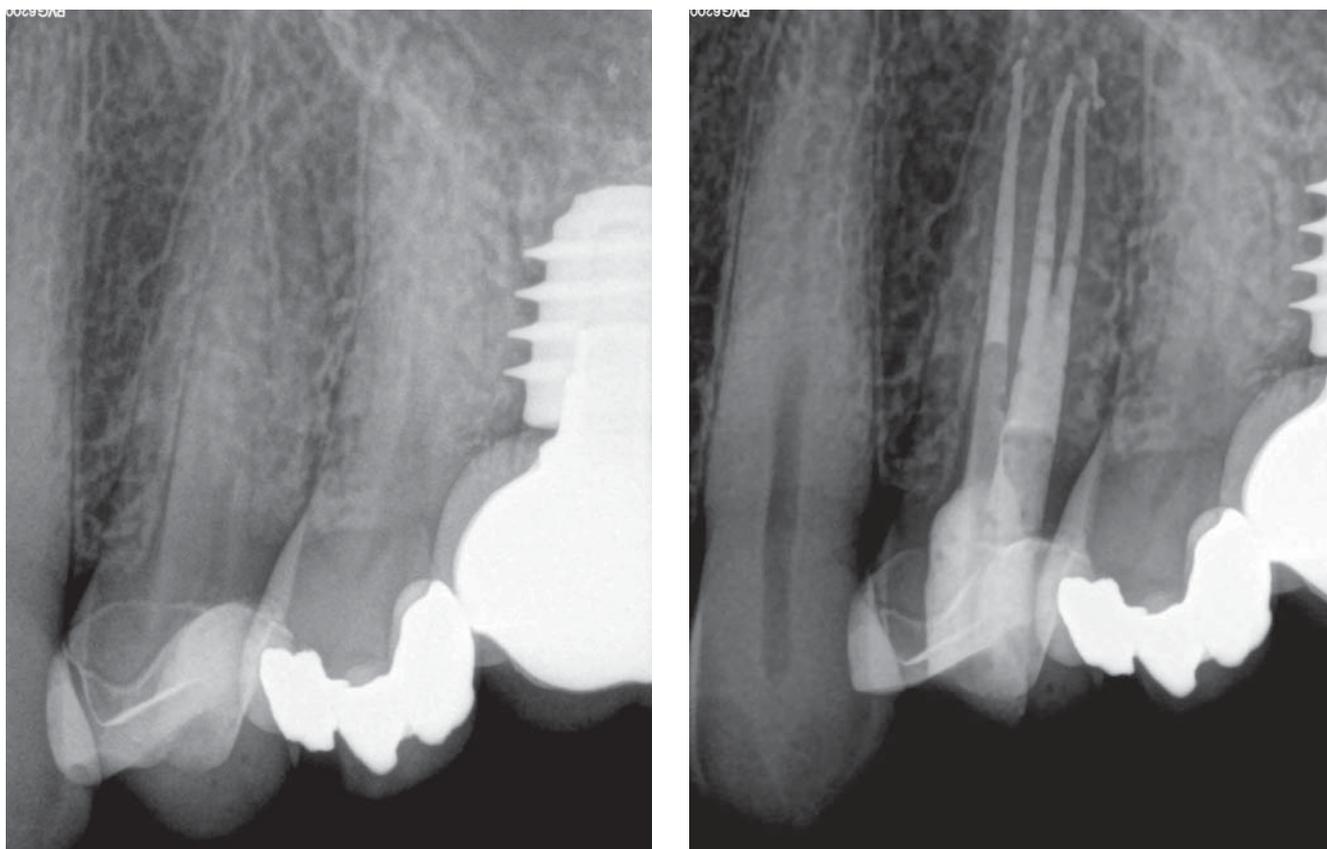
The purpose of recapitulation is to prevent the apical root from compaction and wash them out with the solution. After that, both the instrument and the canal are ready for a new preparation cycle. The rubber stopper is again adjustable 4-6 mm longer or to the working length. Again, the goal of this machining cycle is to traverse the canal completely until the full working length of the endospace is reached.

When the tip of the primary file reaches its full working length, the file is removed from the canal and checked. Some authors argue that the presence of scars on the upper 2-3 mm of the instrument indicates adequate treatment of the apical part of the root. If there are no burrs at the end of the instrument, it is recommended to continue processing with WaveOne Medium and WaveOne Large files. Reaching the apical end with a nickel-titanium file is also another alternative protocol modification [10]. For example, if the final canal preparation was carried out with the 25/07 instrument, then the apical part of the root can be achieved using a 25/02 nickel-titanium file (Dentsply Sirona). If the processing quality is confirmed and corresponds to the size of the 25 GuttaCore Obturator (Dentsply Sirona) used for X-ray inspection, then the cycle can be considered complete. If the 25/02 NiTi file passes freely along the working length and outside of it, this means that the diameter of the apical foramen is greater than 0.25 mm. In these cases, it is recommended to check the apical foramen using a 30/02 nickel-titanium hand file. If this tool fits snugly along the working length then ISO 30 can be confirmed. If the file size 30/02 runs freely along the working length, you can switch to the Medium WaveOne Gold tool or, if necessary, to the Large WaveOne Gold tool. In the clinical case presented in the photo, the hand file size 25/02 fits snugly along the length of the buccal and palatal canals. The adequacy of the fit was also verified with a gutta-percha on the radiograph.

The prepared canals were filled with 17% EDTA solution and activated for 1 minute. After that, the final disinfection is achieved by activating a 3.5% heated sodium hypochlorite solution for 3 minutes, which is activated with the same nozzle. The canals are dried with paper points and obturated with gutta-percha and sealer.

#### **CLINICAL CASE**

A 52-year-old woman presented with irreversible pulpitis of the right first maxillary premolar. The periapical radiograph shows a deep-seated Class II composite restoration (Figure 3a). After the formation of the access, 3 root canals (two buccal and one palatal) were found. All 3 root canals were prepared with a single WaveOne Gold Primary 25/07 file after shaping the carpet using stainless steel K-files and ProGlider. Figure 3b shows the result of the treatment after the glass fiber post and composite restoration.



**Figure 3. Radiograph before treatment (a); radiograph after treatment (b).**

### CONCLUSIONS

The design and specificity of the metallurgical production of WaveOne Gold tools provide increased efficiency of cutting these files, as well as their high flexibility and prevention of fracture when using a single

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tool. In approximately 80-85% of clinical cases, the clinician only needs one Primary WaveOne Gold file for complete canal instrumentation. The WaveOne Gold Primary canal instrumentation technique provides three distinct clinical benefits: safety, ease and success of endodontic surgery.

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