Case Report

Modern rotary files in minimally invasive endodontics: a case report

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1. Abstract

Modern Endodontics aims to remove or decrease the bacterial load within the endodontic space. This target is achieved by performing adequate mechanical preparation combined with three-dimensional cleaning. The first step, shaping, is done using manual stainless steel files and Ni-Ti rotating files. In recent years, new rotating files have been developed in the martensitic phase, which, being more flexible, guarantees to work safely in the case of difficult anatomies. Therefore, this study aimed to demonstrate a non-surgical endodontic treatment using modern Ni-Ti files in a minimally invasive approach.

2. Introduction

The use of Ni-Ti represented a climax in the field of study of Endodontics; actually, it allowed the manufacture of innovative root canal mechanical files, whether hand or rotary instruments. Those new files offer outstanding features compared to stainless steel (St-St), leading to enhanced treatment outcomes [1].

Although Ni-Ti alloy has several benefits, using these rotary files during a root canal treatment or retreatment could risk fracture rather than St-St files [2, 3].

The breaking of the rotating files occurs due to cyclic fatigue and torsion.

The cyclic fatigue of a file occurs when it is subjected to recurring successions of compression followed by a tension that causes the transgression of its structure and ultimately to fracture.

Improvements in the manufacturing process or through utilizing novel alloys with greater mechanical properties were applied to overcome file breakage caused by this type of alloy fatigue in endodontic files.

On the other hand, the torsional fatigue of a file is defined as the winding of the metal over its longitudinal axis at the top whilst the tip is stuck.

The polar moment of inertia plays a crucial role in the cross-sectional aspect in determining the torsion strength of the file when in rotation and also on the cross-section of the metal mass [4].

Ni-Ti alloys utilized in Endodontics are composed of Ni-Ti, equivalent to 55% Ni and 45% Ti [5].

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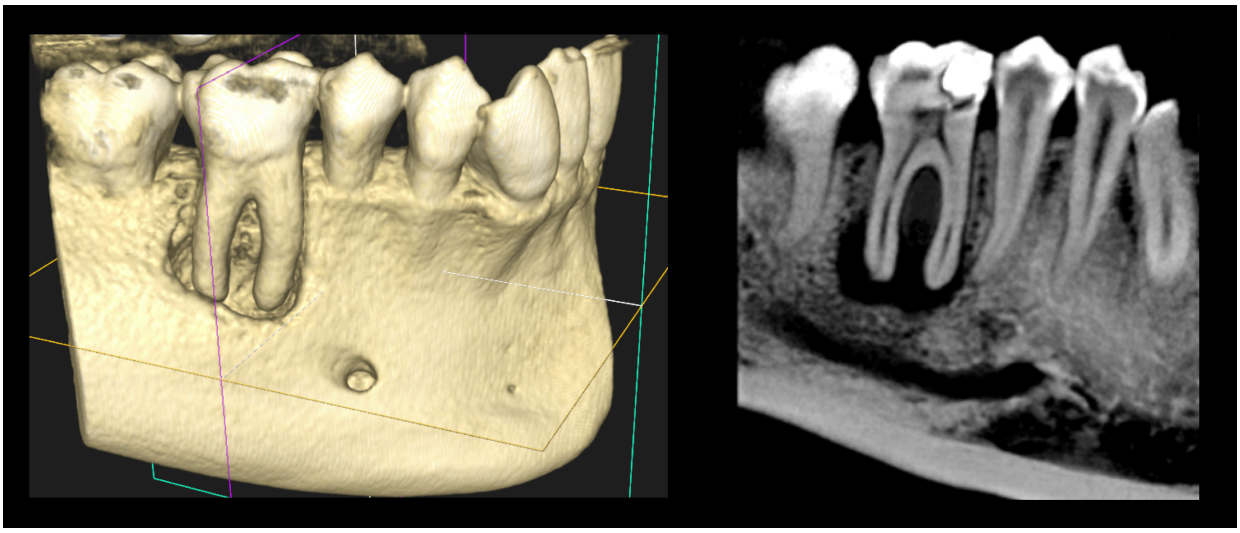

Fig. 1. Preoperative CBCT showing first mandibular molar 4.6 associated with a large periapical lesion.

Heretofore, in order to enhance the functioning of Ni-Ti files was done solely by changing the design of the tip, file size, cross-sectional features, or flute design.

The Ni-Ti rotary files cycle fatigue can be improved in the manufacturing process or by using new alloys with better mechanical qualities, therefore greater cyclic and torsional fatigue resistance.

Many studies have been conducted on the cyclic resistance of different rotary Ni-Ti instruments with different designs or compositions, and modern rotary files in the martensitic phase are much more flexible [6–9].

Although these files are more flexible when compared to traditional Ni-Ti rotary files, they can still be subject to fractures if used in large diameters and tapers, especially in complex anatomies.

By complex anatomies, we mean both accentuated root curvatures and shaping made through minimally invasive access cavities.

Newly, the minimally invasive access cavity design was described in the literature to offer preservation of the tooth structure. This cavity design aims to save valuable parts of the roof of the pulp chamber and peri-cervical dentin. This healthy dentin salvation could be attained with the aid of cone-beam computed tomography (CBCT) to preassess all root canals [10]. This tactic can improve the fracture resistance of root canal treated teeth [10].

Recent research has shown that conservative shaping can achieve excellent results if carried out while performing active cleaning [11]. Shaping with rotating files with low taper and diameters and combining a powerful cleaning leads to clean dentinal walls and leads the irrigants to easily reach lateral anatomies, including the dentinal tubules [12].

Therefore, this study aimed to show a clinical case carried out with new rotary files produced with modified Ni-Ti alloys used conservatively.

3. Materials and methods

A 30-year-old female patient was presented at our clinic complaining of acute pain in the right mandibular area. After clinical and radiographic examination, the diagnosis was a non-vital tooth number 4.6 associated with symptomatic apical periodontitis. The CBCT 3D examination showed a large periapical lesion and a mesial carious cavity (Fig. 1). Root canal treatment was recommended to save the tooth.

The dental dam was applied, and conservative access was made through the mesial cavity.

A small diamond rounded bur with a long shank of 1 mm in diameter was used for the access opening. After reaching the pulp chamber with the bur, an ultrasonic tip for endodontic surgery (Satelec, Acteon, P 14D, North America) was used to clean the undercuts indirectly without removing the occlusal structure of the tooth. During this phase, NaOCl was used as an irrigant.

In this way, only infected dental tissue was removed to save sound tooth structure. By examining the preoperative 3D CBCT, it was possible to analyze the endodontic anatomy before the treatment. Therefore, the entire canal system was also found through a conservative access cavity through conservative access cavity.

The orifices of the root canals were negotiated in the first mm using a small hand file, 0.10 K-file (Coltene/Whaledent, Langenau, Germany).

The protocol to shape root canals safely was as follows:

3.1 Pre-flaring

HyFlex EDM 25.08 (Coltene/Whaledent, Langenau, Germany) shaped the coronal third.

3.2 Scouting

At this point, a pre-bent hand file 0.08 K-file was used (Coltene/Whaledent, Langenau, Germany).

In this phase, the hand file must always be connected to the apex locator.

A 0.10 pre-bent K-file (Coltene/Whaledent, Langenau, Germany) was brought to working length.

3.3 Glide path

HyFlex EDM 15.03 e 10.05 (Coltene/Whaledent, Langenau, Germany) was used to the working length for the glide path.

3.4 Shaping

HyFlex EDM 20.05 (Coltene/Whaledent, Langenau, Germany) was used up to the working length to complete the shaping.

All files, manual or rotary, must always work in the presence of an irrigant to reduce the risk of fracture and remove the debris in a better way.

The working length should not be reached immediately. Therefore, each 2–4 mm towards the working length, the files should be taken out to clean the flutes and irrigate the canals.

Throughout the mechanical steps of scouting, preflaring, glide path, and shaping, the hand and rotary files utilized should constantly and carefully be observed to see if the flutes are intact or damaged owing to stress.

One of the major benefits of the novel rotary files, HyFlex EDM, is that if the flutes open because of stress, they can be regenerated by heat, and the files can be reused without risk of breakage.

It is important to use HyFlex EDM with continuous rotation mode. HyFlex 10.05 and 15.03 should be used at 300 rpm with a torque of 1.6 N cm. The recommended speed for HyFlex EDM 20.05 must be used at 400 rpm with torque 3.0 N cm.

When the shaping phase ended, 3D Cleaning started by using the first saline solution to neutralize the PH. Afterwards, 17% ethylenediaminetetraacetic acid (EDTA) was used for one minute to dissolve the inorganic part of the smear layer. The final solution to be used was 5.25% NaOCl.

NaOCl was inserted through a NaviTip 30G side-vented irrigation needle (CanalPro, Coltene/Whaledent, Altstatten, Switzerland) placed 2 mm away from the working length.

The 3D cleaning technique was done by filling the canals with room temperature 5.25% NaOCl (Canal Pro, Coltene, Whaledent, Germany), which was activated using internal heating combined with ultrasonic activation. NaOCl was directly heated in the canal for 8 s using a System B unit (Analytic Endodontics, Orange, CA) and a Heat Carrier XF (30/04). The temperature was set at 180 °C.

Fig. 2. Postoperative radiograph showing conservative access through the mesial cavity.

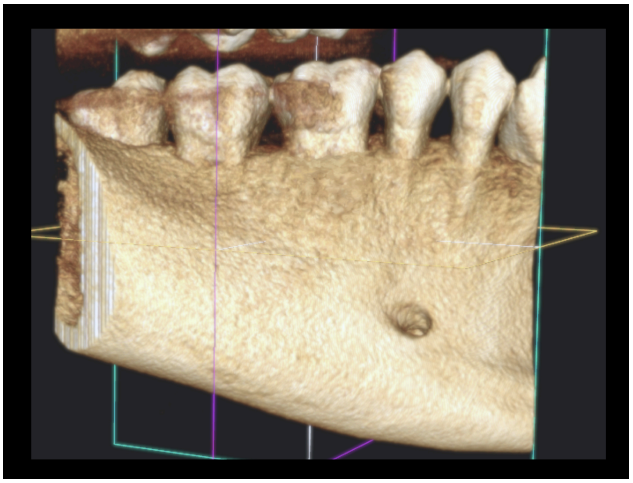

Fig. 3. 8 Months CBCT follow-up showing healing.

When positioning the heat carrier inside the canal, it was introduced 3 mm away from the working length. Whilst the heating procedure is active, the heat carrier was moved with minor up and down movements inside the canal. Lodging the heat carrier in the canal should be evaded. Then, an ultrasonic file/tip (Titanium activator tip 25/02, Coxo, Foshan City, Guangdong Province, China.) was inserted 2 mm away from the WL and activated for 20 s. The cycle of intracanal heating and ultrasonic activation of NaOCl (three-dimensional (3D) cleaning) was recapped five times. The canal was washed with 3 mL of ambient temperature 5.25% NaOCl after each 3D cleaning cycle to refresh the solution. Next, that root canal was dried with absorbent paper points.

Finally, the obturation phase was completed by gutta-percha and sealer using a modified continu-

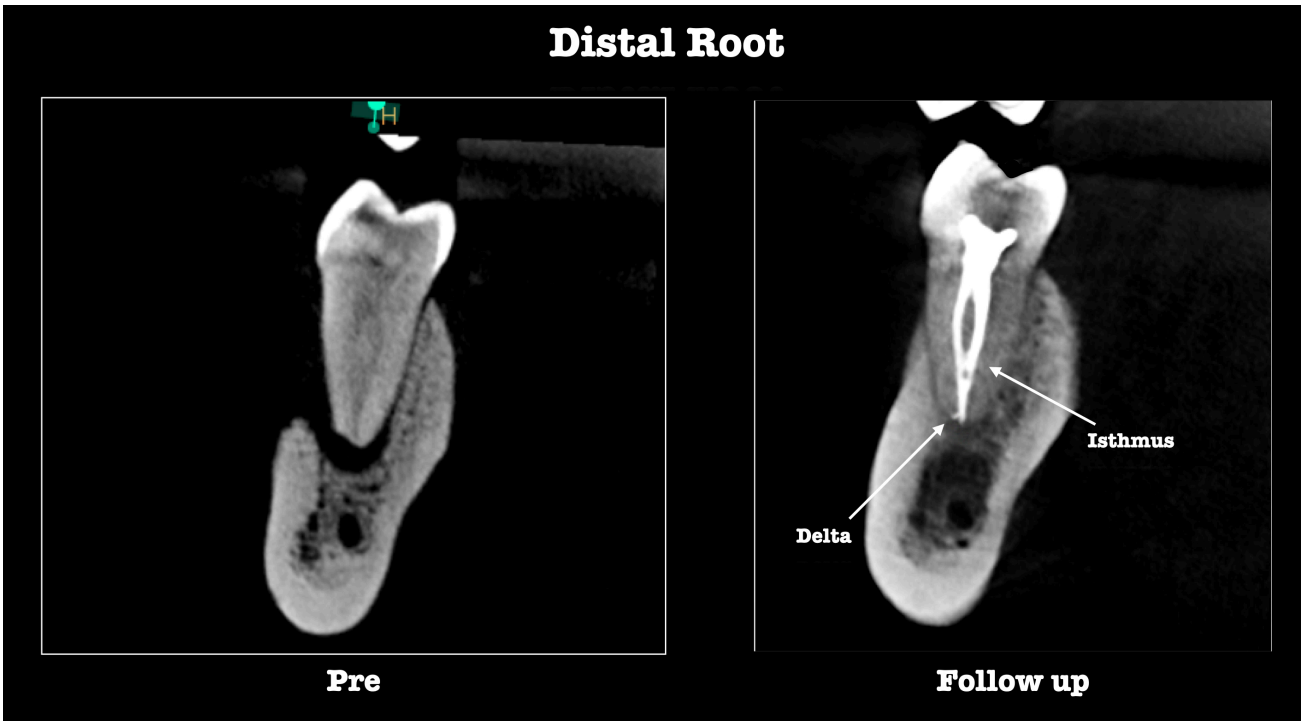

Fig. 4. 8 Months CBCT follow-up showing healing in distal area.

ous wave of condensation and sealer (GuttaFlow Bioseal, Coltene/Whaledent, Altstatten, Switzerland).

When it comes to the direct coronal restoration, a composite resin material was applied. The cavity surface was etched and prepared with tooth bonding adhesive. The composite material was layered in small increments and shaped to the necessary outline. Following the composite resin was polymerized, the restoration was finished and polished (Fig. 2).

4. Results

At the eight-month follow-up, the tooth was asymptomatic. Radiographic examination revealed complete healing. Through the 3D CBCT, it is possible to notice the regrowth of the bone and the disappearance of the big periapical lesion (Figs. 3,4).

5. Discussion

Analyzing the literature, many researchers have proven that cyclic fatigue is considered the predominant factor when it comes to endodontic files material failure. Generally, rotary files show dissimilarities in resistance to cyclic fatigue failure on account of different factors, like the manufacturing process, mechanical characters, geometric designs, and superficial texture. Moreover, it was well established that while numerous aspects can trigger file separation, cyclic fatigue is considered one of the foremost causes.

Multiple studies revealed that the novel rotating files, HyFlex EDM, have exceptional features in respect of resistance to cyclic fatigue [1, 2, 13].

HyFlex EDM rotary files were selected in the current clinical case, given their exclusive properties due to the innovative manufacturing process. The new technology used to create the HYFlex EDM files was done by using electric discharge machining that generates the exceptional surface of the new Ni-Ti files and makes the HyFlex EDM files tougher. Additionally, modern Ni-Ti alloys raise the resistance of the rotary file to cyclic fatigue. Consequently, these features make it nearly perfect to use the Hyflex EDM in a clinical case like the presented one [2].

Recent research has shown that conservative shaping can achieve excellent results when performed in conjunction with active cleaning [11, 12, 14–18]. The shaping with rotating files with conicity and low diameters associated with a powerful cleaning leads to cleaning the dentinal walls and leads the irrigants to easily reach the lateral anatomies, including the dentinal tubules [9, 19]. Small rotating files make it possible to shape curved root canals in safety, avoiding fracture risk. The same goes for shaping root canals through conservative access cavities. When using files rotating through minimal cavities, the files can undergo greater stress, not following perfectly straight trajectories, therefore using modern files in the martensitic phase and small dimensions, it is possible to work in small spaces safely.

Therefore the advantages are faster shaping using few files, lower risk of fracture of the files, greater preservation of root dentin, and good cleansing if using irrigant activation techniques.

Highly performing techniques for activating irrigants are internal heating associated with the ultrasonic activation of NaOCl [9, 20].

With these techniques, even if the canals are shaped conservatively, it is possible to obtain an excellent degree of cleansing both of the dentinal walls and the lateral anatomies, respecting the aim of endodontics [21–23].

Therefore, in root canal treatment or retreatment with severe curvatures and conservative access cavity, these modern rotating files can help the clinician completely shape the root canals up to the working length safely, avoiding fractures of the files.

6. Conclusions

This case report shows how to shape a molar safely with a complex root canal through a conservative access cavity based on the benefits of this new alloy of these new rotating files. Further researches will be needed to confirm this.

7. Author contributions

AI—conceptualization, writing; MP—visualization, supervision; SM—writing, supervision; DA—writing, review and editing; AA—methodology, supervision.

8. Ethics approval and consent to participate

Each patient included in the current study gave written informed consent.

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11. Conflict of interest

The authors declare no conflict of interest.

12. References

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