Endodontic Systems Working With Reciprocal Movements For Instrumentation of Root Canals

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Abstract

It has been accepted that instrumentation of the root canals is one of the important steps for the succes of root canal therapy. Contemporarily, the root canals arebeing instrumented with either stainless steel/nickel-titanium (Ni-Ti) handfilesmanually or with rotary Ni-Ti files used with a torque controlleddevice or handpiece. The handycaps in these methods revealed the need for the development of a new instrumentation system in endodontics. The advantages such as simplicity, low risk of cross contamination, efficacy in proper shaping, resistance to cyclic fatique of the recent reciprocating instruments showed that they are a desirable alternative forthat need. In this article, the new reciprocating systems and their clinical useswere introduced, and the findings of the related research articles were presented based on the current literature review.

Keywords: *Root canal instrumentation, Ni-Ti rotary systems, endodontic resiprocal systems*

Özet

Kök kanallarının şekillendirilmesinin, başarılı bir endodontik tedavinin en önemli aşamalarından biri olduğu bilinmektedir. Günümüzde kök kanalları genel olarak el ile kullanılan paslanmaz çelik ve/veya nikel-titanyum (Ni-Ti) kanal aletleri ya da bir tork kontrollü motor veya redüksiyonlu anguldruva ile kullanılan Ni-Ti döner alet sistemleri ile şekillendirilmektedir. Ni-Ti döner alet sistemlerinin, avantajlarının yanısıra bazı dezavantajlarının da bulunması, yeni şekillendirme sistemlerinin geliştirilmesine neden olmuştur. Güncel resiprokal hareket ile çalışan sistemlerin; kullanım kolaylıkları, çapraz enfeksiyon risklerinin olmaması, kırılma risklerinin düşük olması ve döner sistemler kadar etkin şekillendirme yapmaları, bu ihtiyacı karşılamada iyi bir alternatif olduklarını göstermektedir. Bu derlemenin amacı,kök kanallarının şekillendirilmesinde resiprokal hareket ile çalışan endodontik sistemler ve bu sistemlerin kullanım özellikleri hakkında bilgi vermek ve bu konudaki çalışma sonuçlarını irdelemektir.

Anahtar Kelimeler: *Kök kanallarının şekillendirilmesi, Ni-Ti döner alet sistemleri, endodontik resiprokal sistemler*

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Introduction

The main purpose of root canal instrumentation is to chemomechanically remove inflamed and/or infected pulp tissue, debris and microorganisms away from the root canal system and to prepare the canal for filling.[1-4]

Peters [5]stated that the root canal treatment's success depend on many factors and one of the most important steps is root canal preparation. The canal preparation step involves mechanical cleaning, formation of a space for the delivery of disinfecting irrigants and medicaments, providing the most appropriate canal shape for obturation. Sothe canal shaping procedure influences the results of the following steps of rootpreparation.[6] For this reason, root canal preparation is not only important, but it is essential for the clinicians.

Today, conventional hand file systems with stainless steel and/or Nickel-Titanium (Ni-Ti) or Ni-Ti rotary systems with low speed hand piece and reciprocal systems are used for root canal shaping.

Therefore the aim of the present study was to compare several parameters of current root canals preparation techniques.

Review

In this article, the new reciprocating systems and their clinical uses were introduced, and the findings in articles were compared with rotary and manual systems based on the literature.

Main criteria for the selection of instruments and shaping technique are defined as the ability to clean and shape the root canals adequately and operating safety.[7]

Because of the high elasticity of Ni-Ti alloys, the use of Ni-Ti instruments with the rotary systems provides many advantages to dentists. Some of the advantages are short treatment time and the reduction of complications like zip, ledge or transportation in the root canal.[8]Despite of their many advantages,the necessity of large number of instruments usage, high cost and high fracture possibility in the canal, made clinicians search for an alternative methods for the Ni-Ti rotary systems.[9,10]

As a result, the systems working with reciprocational movement have been developed. Inthese systems; instrument does not make a full rotation, the movement is completed in several times with clockwise and counterclockwise rotations. Stainless steel instruments are used in the first developed systems working with reciprocational movement such as SafeSider (Essental Dental Systems, S. Hackensack, NJ) and American Endodontic Technology (AET) (Ultradent, South Jordan, UT). Due to the use of stainless steel instruments, these systems are cheaper and fracture possibility is less. However these systems have some disadvantages like apical transportation and complexity of large amount of instruments.[11]

In 2008, Yared [12] has developed a new shaping technique by using only ProTaper (Dentsply Maillefer, Ballaigues, Suisse) Ni-Ti rotary system's F2 instrument with a low speed hand piece

making reciprocational movement. Yared concluded that, this system was as successful as the ProTaper rotary system including 5 different instruments, and was a easier system due to the use of a single instrument and there was no risk of cross infection.

Thereafter, an increase has been seen in the studies using this shaping technique. You and friends[13], compared the shaping time of ProTaper rotary systems and ProTaper F2 technique with reciprocational movement by using 120 lower molar teeth with curved root canals (20-45 degrees). As a result it is found that shaping was completed in 46,42 seconds on average with the ProTaper rotary systems and 21,15 seconds with the ProTaper F2 technique with reciprocational movement. The researchers stated that fracture of F2 instrument used with reciprocational movement was seen after 10 uses and it can be used in 6 canals safely.

De-Deus et al. [14]compared the effect ofinstrumentation on apical extrusion of debris. The groups was hand instruments used with crown-down technique, ProTaper rotary systems and ProTaper F2 technique with reciprocational movement. They concluded that hand instruments used with crown-down technique produced the most debris extrusion, while no statistically difference have been found between ProTaper rotary systems and ProTaper F2 technique with reciprocational movement.

De-Deus et al.[15]have used ProTaper F2 instruments in metal blocks with reciprocational and rotational movements in different revolutions and examined the fatigue resistance of the instruments. Researchers have found out that the most successful group was the one which made the reciprocational movement and the group worked in 400 rpm (revolutions per minute) was less successful than the one in 250 rpm.

In another study, De-Deus et al. [9]have evaluated the ProTaper rotary systems and ProTaper F2 technique with reciprocational movement in round and oval canals histologically. They have found out that even though there was no statistically difference in the round canals, ProTaper rotary system was more effective in the oval canals.

Paque et al. [16]have evaluated the change in the volume of root dentin, quantity of the shaped canal, transportation amount and shaping time with tomography after the use of ProTaper rotary systems or ProTaper F2 technique with reciprocational movement in the mesial canals of lower molars. As a result, no statistically difference found between the efficiency of the shaping techniques; reciprocational movement has created more transportation in the coronal dentin, however it was a faster technique.

In a similar study which You et al.[17]made, as a result of comparison of these two techniques in curved canals of lower molars, it was found out that there was no statistically difference in the amount of change in the curve, dentin volume and surface area. Researchers stated that reciprocational system doesn't cause transportation even in the apical part of the curved root canals.

These studies have played an important role in the development of new shaping techniques with a single Ni-Ti instrument and reciprocational movement. Reciproc (WDW GmbH, Munich, Germany), WaveOne (Dentsply Maillefer, Ballaigues, Suisse) and TF Adaptive (Sybronendo, West Collins CA, USA) are similar systems developed in the last years.

The shaping systems with reciprocational movement and the ones most widely used in literature are described below with their working principles.

SafeSider System

The design of SafeSider root canal instruments are based of reamer type files. Reamers, on the other hand, are loosely twisted triangular wires that make 3 point contact with every flute. Each flute on a reamer makes less contact than a file. As a result, reamers instrument canals with less hand fatique, less distorted instruments. The flat-sided design of the EZ-Fill SafeSider reamers derives from the understanding that a reamer design is significantly better than a file design because it engages less dentin. Consequently, a relieved SafeSider designed reamer must be significantly better than a conventional reamer because it engages even less dentin at any one time and also has a thinner cross-sectional area making it more flexible. Thus SafeSider instruments may be used many more times when compared with traditional hand files, with minimum fatique even in curved canals.

Wan et al. [18] examined the effect of flute number and cross-sectional area on the cutting efficiency of 3 hand instruments of 40/0.02 used in reciprocating handpiece (Group 1, SafeSiders; Group 2, Dentsply K-Files; Group 3, Dentsply K-Reamers). They found that Safesider instruments produced a greater amount of debris than K-Files and K-Reamers. The flute number had no effect on cutting efficiency and cross-sectional area may be determining factor on cutting effiency.

In SafeSider system, .02 tapered stainless steel instruments between #08 to #40, .04 tapered #30 and .06 -.08 tapered #25 NiTi instruments are avaible. SafeSider system has a special handpiece named Endo-Express working in reciprocating motion at 2500-3000 rpm.[19]

SafeSider Technique

- Determine the working lenght
- Instrument the apex thru a No.20 SafeSider reamer
- Use a No.2 peeso reamer to straighten and deepen the flare of the canal
- Instrument the apex thru a No.25
- Instrument the apex with No.30 SafeSider stainless steel reamer
- Instrument the apex with No.35 SafeSider stainless steel reamer
- Instrument 1mm short of the apex with No.40 SafeSider stainless steel reamer
- Now use the No.2 Gates glidden to further staighten and deepen the flare of the canal
- Instrument the apex with No.30/.04 NiTi SafeSider reamer
- Instrument the apex with No.25/.08 NiTi SafeSider reamer
- The canal is ready to receive an .08 tapered medium gutta percha point.

Reciproc System

Reciproc system completes the rotation of 360 in several reciprocating movements. In reciprocation, the instrument is driven first in a cutting direction and then reverses to release the instrument. The angle in the cutting direction is greater than the angle in reverse direction, so that the instrument continously progresses towards the apex. Reciproc has a non-cutting tip and produced with M-Wire nickel-titanium. M-Wire technology is achieved through the use of this alloy produced in an innovative thermal-treatment process and has both greater resistance to cyclic fatique and greater flexibility than traditional nickel-titanium. Reciproc instruments are S-Shaped and marked with the ISO colour of the instrument tip size for easy identfication. R25 prepares the root canal to an ISO size 25 with taper .08 over the first apical milimeters. R40 prepares the root canal to an ISO size 40 with .06 taper and R50 with .05 taper. Reciproc instruments have a short shaft of 11 mm enabling easier root canal preparation on molar region, compared to many other instruments which have a shaft of 13 mm or longer. A reciproc instrument is designed for single use in maximum one molar. If an istrument appears to be bent after being used in a strongly curved canal, it sholud be discarded. The Reciproc system is designed for convenience and safety. Instruments are delivered ready to use, pre-sterilised in blister packaging and should be simply discarded after use, making work flow more efficient, eliminating the need to clean and sterilise instruments, considerably reducing the risk of cross-contamination.

Reciproc Technique

- Select the correct Reciproc instrument.
- 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
- After determining the file, place irrigant in the endodontic cavity of the root canal.
- Select the appropriate Reciproc instrument and secure it in the handpiece of the motor.
- Check that the Reciproc motor setting has been selected.
- Introduce the Reciproc instrument into the canal, Press the motor foot pedal when the instrument is at the root canal orifice.
- Move the instrument in a slow in-and-out pecking motion. The amplitude of the in-and-out movements should not exceed 3mm. Only very light pressure must be applied.
- After 3 pecks, remove the instrument from the canal. Clean the debris from the flutes.
- Irrigate the canal.
- 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 10 C-Pilot file. When using an R40 or R50 the working length should be rechecked with an apex locator.
- As soon as full working length has been reached, withdraw the instrument from the root canal.

WaveOneSystem

The system is generally similar to Reciproc system. It also has 3 files Small, Primary and Large avaible in length of 21, 25 and 31 mm. WaveOne system has a special file geometry and M-Wire technology which are the main reasons for superior performance compared to most of Ni-Ti files on the market. They also have pre-sterilised blister packs and fitted with a non autoclavable handle. WaveOne system has tapered paper points and gutta-percha points special for the system. The manufacturer states that the root canal may be filled either with this tapered gutta-percha points and lateral condensation or WaveOne obturators.

WaveOne Technique

- The Primary (025/08) file (025 apical size/08 taper) is designed to fully shape the majority of all root canals.
- If a K-File 10 is very resistant to movement then the size is Small (021/06) This may include mandibular incisors, MBII canals within maxillary molars, and/or canals that exhibit apical curvatures.
- If a K-File 020 easily goes length then the size is Large (040/08) This may include maxillary incisors, single-canal bicuspids and some larger diameter molar canals.
- Establish straight-line coronal access to the orifice.
- Estimate the working length using well-angulated preoperative radiographic or digital images.
- Create a glide path by gently working a 010 file, using irrigation or a viscous chelator as preferred until resistance is met and the file doesn't progress anymore. Then work until it is completely loose.
- Select proper the WaveOne file.
- Use some irrigant on canal orifice and initiate shaping procedure with 2-3 mm amplitude pecking motion.
- Withdraw the WaveOne file, remove the debris and inspect the cutting flutes, irrigate and repeat the procedure until the two-thirds of the canal have been shaped.
- Check the apical patency with a 010 K-file and use the WaveOne file to final working length.

Twisted File (TF) Adaptive System

TF Adaptive has a R-Phase heat treatment technology. This proprietary technology optimizes the metalurgy of Ni-Ti files making them %70 more flexible and 2-3 times more resistant to cyclic fatique than the other rotary files. Twisting optimizes Ni-Ti grain structure and eliminates formation of microfractures, making the file even more durable. Other endodontic files are made by grinding flutes in the file, weakening the metal's structure which can lead to file seperation. The elements motor is a special torque controlled motor for TF system which adapts the motion based on the amount of pressure on the file. Reciprocating angles may vary to 370° forward and up to 50° backwards based on file load.

TF Adaptive Technique

- Obtain staight line access to coronal 1/3 of the canal.
- Achieve patency and establish an apical glide path using #8 through at least a #15 hand file.
- Canal size and file sequence determination. There are two sequences for instrumentation.

Small (SM1 20/.04, SM2 25/.06, SM3 35/.04) and Medium/large (ML1 25/.08, ML2 35/.06, ML3 50/.04)

- Small Canals (SM) use tactile feel, if you struggle to get a #15 to working length then the canal size is small. Use small sequence. If #15 is loose then the canal size is medium/large. Use medium/large sequence.
- TF adaptive system:
- Use the TF adaptive setting on your motor.
- Ensure the pulp chamber is flooded with NaOCl or EDTA and make sure the file is rotating as you enter the canal.
- Slowly advance the green (SM1 or ML1) with a single controlled motion until the file engages dentin then completely withdraw the file from the canal. Do not force apically. Do not peck.
- Wipe off the flutes. Deliver irrigant to the pulp chamber and confirm canal patency with a #15 K-file.
- Repeat the procedure until working length.
- Repeat the steps with yellow SM2 or ML2 until working length. If the desired apical size is achieved sequence is complete.
- For larger apical sizes repeat steps with red SM3 or LM3.
- You may use TF Adaptive matching gutta-percha or obturators.

Barletta et al. [21] used computed tomography (CT) to assess techniques for root canal filling removal. Seventy-five roots of extracted human lower incisors were filled with zinc-oxide eugenol sealer and gutta-percha and separated into three groups before gutta-percha removal (group 1, Gates Glidden burs+ K-type hand instrumentation; group 2, K-type reciprocating instrumentation with handpiece; group 3, ProTaper rotary instrumentation). Reciprocating instrumentaion was the most effective and the manual instrumentation associated with GG burs was the least effective technigue.

Eid and Amin[22] compared the shaping ability of manual H-Files, rotary nickel-titanium ProTaper System and reciprocating SafeSiders in long oval-shaped (human lower premolars) canals under microscope. Results showed that none of the 3 instrumentation techniques completely prepared the oval root canal. Manual and rotary Ni-Ti instrumentation may perform better than reciprocating Safesider instrumentation in shaping oval canals.

Karataş et al [23] compared the incidence of root cracks after root canal instrumentaiton with TF Adaptive, WaveOne, Protaper Next and Protaper Universal systems under stereomicroscope. They concluded that the Protaper Next and TF Adaptive systems produced significantly less cracks than the ProtaperUniversal and WaveOne systems.

Hiquea et al. [24] evaluated the cyclic fatique resistance of 3 different Ni-Ti reciprocating instruments. Group 1 (WaveOne Primary), Group 2 (Reciproc R25), Group 3 (TF Adaptive ML1 instruments). The instruments were subjected to cyclic fatique test on a static model consisting of a metal block with a simulated canal with 60° angle of curvature and a 5-mm radius of curvature. Cyclic fatique of Reciproc R25 and TF adaptive ML1 was significantly higher than that of WaveOne Primary.

Karataş et al. [25] compared the effect of the TF Adaptive, ProTaper Next, OneShape, WaveOne, Reciproc, SAF on the reduction of E.faecalis in experimentally infected root canals. Analysis of results showed that the ProTaper Next, TF Adaptive, WaveOne, Reciproc and OneShape systems were significantly more effecective than the SAF system in reducing E.faecalis within the root canals.

Priya et al.[26]compared the incidence of dentinal micro cracks after instrumentation with various types of NiTi files in rotary and reciprocating motion. In their study one hundred human extracted mandibular central incisors were taken and divided into 10 groups (n=10 teeth per group). Group 1- No preparation, Group 2 - Hand instrumentation, Groups 3,4 - ProTaper files in rotary and reciprocating motion, Groups 5,6 - ProTaper Next files in rotary and reciprocating motion, Groups 7,8 - Oneshape files in rotary and reciprocating motion, Groups 9,10 - Reciproc files in rotary and reciprocating motion. Specimens were sectioned horizontally at 3,6 and 9 mm from the apex and dentinal micro cracks were observed under a stereomicroscope. They concluded that least cracks were seen in canals instrumented with Pro Taper Next files both in rotary and reciprocating motion. Full sequence rotary systems showed less cracks than single file systems and full sequence rotary systems showed less cracks in reciprocating motion than in rotary motion.

Conclusions

As a result, day by day the new reciprocal movement systems are being developed and offered to endodontic practice.

The literature review reveals that the reciprocal systems are faster to shape root canals than the rotary systems and safe as much as them. The main advantage of current reciprocal systems is having a single filefor root canal shaping. So the procedure is easy, time saving, prevents cross-contamination and has minimum risk of file fracture. Besides these advantages, the studies shows that they are effective to shape such as rotary systems and these benefits may indicate that they will take an important role in future endodontics.

However the reciprocal systems are quite new and many in vivo and in vitro studies are necessary to evaluate them. Besides it is known that the use of irrigation solutions in root canal cleaning and shaping procedure have a very important role for disinfection. In standard root canal therapies performed either with rotary and hand-files, 2 ml of root canal irrigant was used between each file which is essential for antimicrobial effect and soft tissue dissolution. Thus the need for a new irrigation procedure for one filed reciprocating systems will be a new subject in endodontics in order to obtain successful root canal therapies.

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