

Reciprocal and continuous rotation is two sides of the same coin

Abstract

The birth of modern Endodontic occurred with the appearance of NiTi rotary instruments on market around 1993. The reciprocal and continuous rotational tools are successive evolutions of the rotary motion techniques, which are closely associated with rapid cleaning and shaping of the root canal system.¹ A multitude of studies has been performed in the last years, substantiating their high efficiencies, studying their specific characteristics, proposing unifying theories, and testing possible countermeasures.^{2,3} To date, however, the role of an instrument's motion in long-term researches has not been explicitly tested. Here the literature review was specifically interested in whether an instrument's motion patterns can affect its characteristics. To that end, we used a simple classification where both movements were categorized on the basis of dynamic properties such as cyclic fatigue, And biological properties (apical extrusion of bacteria).⁴

Keywords: reciprocal, continuous, cutting efficiency, cyclic fatigue, cracks, bacterial, extrusion

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Introduction

One of the most fundamental tasks for the endodontist is to recognize the instruments that are mostly used in Root canal treatment. In order to do this task it is assumed that he should be aware of all their properties for optimal recognition performance.¹ For example, a shape or part structure, color, or texture may reveal information unique to this instrument that can be used for recognition.⁵ However, those files are not stationary and the manner in which an instrument moves can often act as a unique signature for the identity of it.^{1,5} Therefore, the aim of the present study wasn't to decide whether to choose between reciprocal or continuous motions. The two techniques may give the same success rate but they are significantly different in their theory, application procedures, characteristics and form of the results.⁶

Cyclic fatigue

Fatigue is an important parameter for determining the behavior of mechanical files functioning under variable loads. The fatigue resistance of a structural component is affected by mechanical, metallurgical, and environmental variable factors.^{7,8} Fatigue is the primary reason for 80–90% of instrument fracture. Hence, In the case of rotary instruments, the files often break due to over usage or to the complexity of the root canal system.¹ Many papers reported that the reciprocal motion was associated with significantly higher cyclic fatigue resistance than with continuous one.^{9,10,11,12} The results obtained are shown in the graph below (Figure 1). According to this graph, the reciprocal instruments may be used more often than the continuous ones before they break. As a matter of fact, Perez-Higueras et al reported that many continuous rotation instruments had better cyclic fatigue resistance when moved with reciprocating motion (144° CW and 72° CCW).^{13,14} Perhaps the most compelling evidence is the evaluation done by De-Deus et al.,^{15,16} they found that the reciprocating motion significantly extended the cyclic fatigue life of the originally continuous rotation ProTaper F2 instrument, compared to conventional rotation. Several other publications outlined the same result using other types of instruments.^{17–22} There is not only a significant difference between reciprocation and continuous rotation

but also a significant difference between different reciprocating motions with different angles of rotation.²³ Remodeling the amplitude of reciprocation has a significant influence on the cyclic fatigue life of NiTi files.²⁴ By the same token, Gambarini et al stated that the differences in the cyclic fatigue resistance of different reciprocating angles may be inversely proportional to the angle of rotation.²³ However, regardless of the instruments used in the mentioned studies, the most important variable affecting the cyclic fatigue of the files remains the complexity of the system. The more complex is the root canal, the less is the resistance.^{21,25}

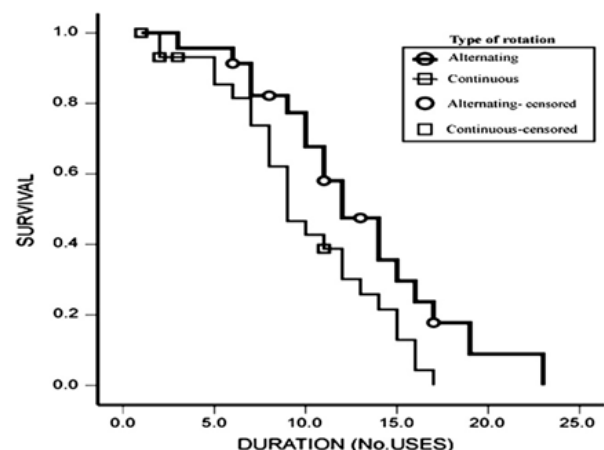


Figure 1 Survival curves (duration) of the instruments with the two types of movement.

Cutting efficiency

The object of cutting efficiency is to remove the maximum amount of tooth structure with the minimum amount of effort and time, and several factors are involved. Cutting efficiency may be improved with a technic that allows bulk removal of tooth structure to depths controlled by the instrument.^{1,26} Even though the higher the cutting efficiency is, the less time and action it takes, this feature may lead

to higher accumulation of debris in the canal. Therefore, the cleaning of the canal will be harder and the screw-in effect may be frequent in such cases.¹ Many Reports have shown that Reciprocal tools have a higher cutting efficiency than the continuous tools. However, after excluding the effect of the design and alloy variables, Stern et al.,²⁷ found that using a single ProTaper F2 Universal instruments with the reciprocating motion of ATR Technika motors removed a similar dentine volume to that produced when using a full sequence of the same instrument with rotational motions.²⁷ Other studies also found no differences in cutting efficiency when comparing same instruments in different kinematics indicating that the type of movement has no effect on the cutting capacity of instruments.²⁸

Dentinal damage and apical transportation

Vertical root fractures (VRFs) are mostly resulted from a poor prognosis for the affected tooth and should therefore be avoided.¹ Local stress concentrations have been presented as the starting point of VRFs. Dentin defects, created by rotary instruments, may act as stress concentration areas, spread from recurred stresses generated as a result of further endodontic and restorative procedures, and ultimately develop into a VRF.^{29–32} To prevent VRFs, safer instruments and techniques should be sought and preferred.³³ Accordingly, many authors such as Rui Liu et al.,³⁴ had listed in their researches that it is much safer to use Reciproc files due to the fact of producing less dentinal cracks.^{35,36} The results supporting this conclusion are shown in the histogram below (Figure 2).³⁴ However, recently, Hwang et al. reported that there was no causal relationship between canal preparation with rotary/reciprocating systems and micro-cracks formation.³⁷ On the other hand, NiTi systems with different motions have been produced to maintain the original canal shape and thus keep it better centered.^{38–41} Reciprocating single instruments may show better centering in the root canal due to the fact that a single file is used to shape the canal rather than a gradual sequence used in continuous rotating instruments.^{42,9} But other studies showed that rotary instruments resulted in less transportation than reciprocating instruments. In the study of Zhao et al.⁴³ ProTaper Universal and WaveOne made similar canal curvature transportation, whereas ProTaper Next had significantly less transportation. This difference can be explained by the taper of ProTaper Next being less than ProTaper Universal and WaveOne.⁴³

Bacterial apical extrusion

Cleaning and shaping of root canal system is a main act during endodontic therapy. One of the weightiest complications might be the apical extrusion of bacteria during the instrumentation procedures.^{44,45} Less bacterial extrusion means lower risk of reinfection. On the positive side, Researchers have become progressively concerned about reciprocating files. Consequently, favorable results might be predictable. On the negative side, a wide range of experimental papers on the issue have come to inconsistent conclusions.^{46,47} One article compared debris extrusion associated with ProTaper and Mtwo with that of Reciproc and WaveOne, it was found that more debris extrusion was associated with the latter 2 systems.⁴⁸ On the other hand, others reported that reciprocating instruments produced less debris extrusion compared with rotary instrumentation.^{49–53} Also a number of studies showed no significant difference between the two systems.⁵⁴ The probable reasons of the conflicting results could be the variability of files designs, the number of files used and the canal anatomy differences between the studies.

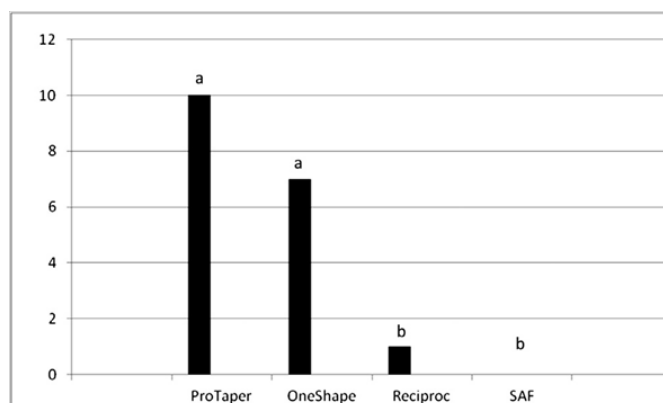


Figure 2 The total number of cracked teeth with different instrumentation techniques. Different letters denote statistical significance.

Conclusion

In conclusion, various methods have been used to measure the results in validation studies. This study concludes that the Reciprocal motion is the most adequate motion that has been used for an ultimate treatment result.⁵⁵ Reciprocal files have a better fatigue resistance, a better cutting efficiency and a minimum of dentinal damage.^{55,56} However, reciprocal and continuous instruments have the same success rate.⁶ Besides, some cases might only be worked with continuous motion technique. Hence, it is important for the clinician and medical researcher to be aware of this issue because erroneous and misleading conclusions from random papers may lead to the application of inaccurate instruments in clinical practice.^{57–61}

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Conflict of interest

The author declares that there is no conflict of interest.

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