Shaping Ability of WaveOne Reciprocating Ni-Ti Instrument In Curved Root Canals (In Vitro Study)

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Dedication

To my great father and to the soul of my mother, to whom I will never find the adequate words to express my gratitude for their love and support throughout my life, to my dear husband, brother and sister for their endless love, support and encouragement and finally to my best friends.

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The goal of biomechanical root canal preparation is to remove all the canal contents, specifically the microorganisms. This is done by enlarging and shaping the canal to allow for adequate chemical debridement, while preserving the radicular anatomy. Regardless of the instrumentation technique, cleaning and shaping procedures invariably lead to dentine removal from the canal walls. However, inadequate dentine removal from root canal walls deviating the main canal axis is known as 'canal transportation'. Transportation impedes adequate cleaning of the root canal because some uninstrumented areas are left, favoring the presence of non-vital or necrotic tissue, whereas other areas can be extensively worn, thus compromising treatment prognosis.

The introduction of NiTi alloy for hand filing and later the launch of engine driven instruments have altered the canal shaping procedure over past two decades. NiTi instruments possess high flexibility and torsional resistance; by using these one can effectively decrease aberrations in canals.

The instrumentation techniques that use automated systems can be carried out with continuous (rotary) or reciprocating (alternated/oscillatory) movements.

New generation nickel-titanium rotary instruments such as ProTaper are designed to provide the minimum number of instruments that can efficiently and safely prepare a fully tapered shape. A unique feature of ProTaper files is that each instrument has

varying percentage tapers over the length of its cutting blades. With this geometry, rotary instruments can cut dentine more effectively and may therefore reduce torsional loads. However, more aggressive cutting could produce increased canal transportation.

The new reciprocating WaveOne NiTi file system is a single-use, single file system to shape the root canal completely from start to finish .The files are manufactured using M-Wire technology, improving strength and resistance to cyclic fatigue by up to nearly four times in comparison with other brands of rotary NiTi files. characterized by different cross sectional designs over the entire length of the working part, modified convex triangular cross section at the tip end and a convex triangular at the coronal end.

Lack of knowledge about the effect of reciprocation on shaping of root canal to a continuously tapering funnel shape to fulfils the biological requirements for adequate irrigation to rid the root canal system of all bacteria, bacterial by-products and pulp tissue and provides the perfect shape for 3-D obturation with gutta-percha.

Hence the purpose of this study is to compare and evaluate canal preparation using ProTaper rotary Ni-Ti and WaveOne reciprocating Ni-Ti for canal transportation, remaining root dentine and centering ability assessed by CBCT.

One of the key goals of root canal treatment is the disinfection of the root canal system , this is achieved via chemomechanical means.[1] This later term was coined to describe the process of mechanically preparing the root canal system to allow the introduction of irrigants enabling maximal effects over the largest surface area. Ideally, root canal shaping should create a continuous tapered preparation from crown to apex while maintaining the original path of the canal and keeping the foramen size as small as practical. [2]These objectives are difficult to achieve by using stainless steel hand instrumentation. [3]

The introduction of Nickel Titanium (NiTi) metallurgy to endodontic instrument manufacture offered many potential advantages over stainless steel instruments including greater flexibility and resistance to deformation.[4]

1-Rotation and reciprocation motion :

Rotation is a circular movement of an object around a center or point of rotation. The greater tactile touch and efficiency gained when continuously rotating Ni-Ti files in small diameter and more curved canals must be balanced with the inherent risks associated with torque and cyclic fatigue failures. Fortunately, these risks have been virtually eliminated due to

continuous improvement in file design, Ni-Ti alloy, and emphasis on sequential glide path management .[5]

The disadvantages of these systems have been in some cases complexity, and in many cost. Ni-Ti rotary instruments such as ProTaper have a modified cross-sectional design as compared to other rotary instruments. With this convex triangle cross-sectional design which characterized by a progressive taper within the same file, it cuts dentine more electively, and may therefore reduce torsional loads. However more aggressive cutting could produce increased canal transportation.[6]It has been considered for some time that the goal in mechanically driven instrumentation is the single file system.

The reciprocating motion can be described as an oscillating motion or repetitive back and forth motion or an alternating rotation where an instrument rotates in one direction and reverses direction before completing a full rotary cycle.[7]

A reciprocating instrument travels a shorter angular distance than a rotary instrument, which subjects the instrument to lower stress values. Consequently, an instrument should have an extended fatigue life when used in

reciprocation as opposed to rotary motion. The development of endodontic instrument used in a reciprocating manner aims to reduce the incidence of breakage. It mimics manual movement and reduces the various risks associated with continuously rotating a file through canal curvature and decrease screw in the canal. [7]

Watch winding is a reciprocating back and forth (clockwise\ counterclockwise) rotation of the instrument in an arch . It is used to negotiate canals and to work files to place. Light apical pressure is applied to move the file deeper into the canal. [8]

In 1985, Roane et al [9] introduced the balanced force technique using instrument in rotational reciprocation for the preparation of curved root canals. They were first report the use of hand files with unequal clockwise and counter-clockwise movements in reciprocation. The efficacy and the safety of this technique were questioned considering the relatively high incidence of procedural complication, such as instrument fracture and root perforation. [10]

Rotary instruments fail via two mechanisms, flexural fatigue and torsional fatigue.[11] The later occurs when the

instrument engages the canal wall and continues to rotate. The instrument initially undergoes elastic deformation, a phase in which it will return to its original state if the torque applied is removed. If torque continues to be applied the instrument will undergo plastic deformation, a state in which it will not rebound to its original conformation.[11]

The point between elastic and plastic deformation is known as the elastic limit, if the instrument in use does not reach this critical point until later in use, deformation will be delayed and the instrument will have an extended working life. In his landmark paper Ghassan Yared[12] described the use of reciprocation to delay taking a NiTi instrument to the elastic limit.

Yared[12] described the use of a ProTaper™ F2 file in a reciprocating handpiece. Previously, reciprocation in endodontics had described a motion with equal clockwise and anti-clockwise motion. In Yared's paper, a Modified Reciprocation was described (originally outlined in an unpublished thesis by Thompson, 2006[13]) in which clockwise and anti-clockwise motions were unequal, the effect of this is that after a number of reciprocations the file will undergo a complete revolution. It was concluded that reciprocation led to an increase in time to failure

for the instrument and this movement/file combination was a genuine opportunity to realise a single file system for canal preparation.

Following this initial work, two systems have come to market. WaveOne and Reciproc. WaveOne is based upon the ProTaper file architecture and Reciproc on MTwo file architecture. One key difference from their rotary counterparts is that the principal movement is in an anti-clockwise direction and cut in a counter-clockwise direction. Both files are manufactured from M-Wire technology (thermomechanically treated Ni-Ti) to improve strength and resistance to cyclic fatigue. [14]

The evidence clearly indicates a mechanical advantage to the use of these files. A key aim of canal preparation is to respect the original canal anatomy. Both WaveOne and Reciproc have been shown *in vitro* to respect canal anatomy.[15]

Another study compared debris accumulation during use of Reciproc, WaveOne, Mtwo and ProTaper files.[16] It was found that apically Reciproc performed better, with less debris accumulation. An in vitro study on the ability of Reciproc to effect bacterial elimination in oval-shaped canals demonstrated comparable results to other files systems studied.[17]