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Original Research

Canal shaping with WaveOne primary reciprocating files and protaper system: A comparative study

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ABSTRACT:

Aim: The need for our study was to compare and analyze canal shaping ability of Wave One files with that of Pro-Taper system files. **Methodology:** Forty sample teeth were used inserted in a plaster of paris rectangular block. In all specimens, the glide path was achieved with PathFile 1, 2, and 3 at the working length (WL). Specimens were then assigned to 1 of 2 groups for shaping: specimens in group 1 were shaped with ProTaper S1-S2 at the WL and specimens in group 2 were shaped with WaveOne Primary reciprocating files at the WL. Analysis of the curvature-radius ratio (CRr) and the relative axis error (rAe), representing canal curvature modification were done. Data were analyzed with one-way balanced analyses of variance at 2 levels ($P < .05$). **Results:** The instrument factor was extremely significant for both the CRr parameter ($F1 = 9.59$, $P = .004$) and the rAe parameter ($F1 = 13.55$, $P = .001$). **Conclusion:** Canal modifications are reduced when the new WaveOne NiTi single-file system is used.

Keywords: Canal centering, Canal shaping, Wave- One, Pro-Taper.

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INTRODUCTION

Root canal shaping is one of the most important steps in canal treatment.[1] It is essential in determining the efficacy of all subsequent procedures, including chemical disinfection and root canal obturation.[2] However, even if this stage is adversely influenced by the highly variable root canal anatomy,[3] it aims to achieve complete removal of the vital or necrotic tissue to create sufficient space for irrigation.[4] Furthermore, shaping tends to preserve the integrity and location of the canal and apical anatomy in preparation for an adequate filling. The avoidance of both iatrogenic damage to the root canal structure and further irritation of the peri-radicular tissue is demanding for all the newest instrumentation techniques. Maintaining the original canal shape using a less invasive approach is associated with better endodontic outcomes. Previous studies have shown that canal transportation leads to inappropriate dentine removal, with a high risk of straightening the original canal curvature and forming ledges in the dentine wall. Nickel titanium (NiTi) rotary instruments have shown efficiency in achieving optimal root canal shaping, with less straightening and better centered preparations of curved root canals. The super-elasticity of NiTi rotary files may allow less lateral forces to be exerted against the canal walls, especially in severely curved canals, reducing the risk of canal aberrations and better maintaining the original canal shape. However, in clinical practice, these instruments

may be subjected to fracture, mainly because of flexural (fatigue fracture) and torsional (shear failure) stresses. Torsional stresses may be increased with a wide area of contact between the canal walls and the cutting edge of the instrument. To reduce such stresses, the ProTaper rotary design combines multiple progressive tapers, adequately maintaining the original canal curvature. Canal curvature is suspected to be the predominant risk factor for instrument failure because of flexural stresses and cyclic fatigue. The clinician can do very little to prevent or reduce such stresses. The reciprocating motion of the NiTi rotary instrument has been shown to decrease the impact of cyclic fatigue compared with rotational motion. Therefore, it has been recently proposed that the single-file shaping technique may simplify instrumentation protocols and avoid the risk of cross-contamination. Moreover, the use of only one NiTi instrument is more cost-effective, and the learning curve is considerably reduced.[5] The new WaveOne NiTi single-file system has been recently introduced by Dentsply Maillefer.[6] The system is designed to be used with a dedicated reciprocating motion motor. It consists of 3 single-use files: small (ISO 21 tip and 6% taper) for fine canals, primary (ISO 25 tip and 8% taper) for the majority of canals, and large (ISO 40 and 8% taper) for large canals. The files are manufactured with M Wire NiTi alloy. The WaveOne Primary file has the same tip size and taper features as the ProTaper F2 but a variable section and reverse cutting blades. The purpose of this study was to compare the ability of the WaveOne Primary file with the ProTaper system in preserving canal anatomy.[7] When shaping canals, it should be appreciated that there are both advantages and disadvantages associated with utilizing continuous rotating vs. a reciprocating movement. The greater tactile touch and efficiency gained when continuously rotating NiTi files in smaller-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 designs, NiTi alloy, and emphasis on sequential glide path management (GPM). Compared to reciprocation, continuous rotation utilizing well-designed active NiTi files requires less inward pressure and improves hauling capacity augering debris out of a canal.[8] On the other hand, a mechanical reciprocating movement has merit because it somewhat mimics manual movement and reduces the various risks associated with continuously rotating a file through canal curvatures. However, current motors that drive reciprocating shaping files through equal forward and reverse angles generally require multi-file sequences to adequately prepare a canal. Further, systems that utilize small, equal CW/CCW angles have recognized limitations, including decreased cutting efficiency, more required inward pressure, and a limited capacity to auger debris out of a canal. As such, there has been a genuine desire to rethink reciprocation and optimize the motors and files that utilize this concept.[9]

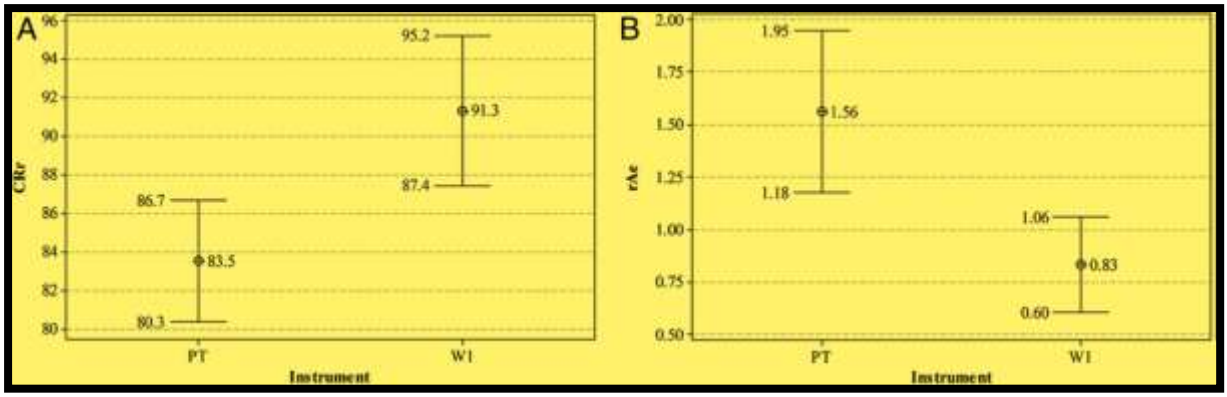
AIM OF THE STUDY

The need for our study was to compare and analyze canal shaping ability of Wave One primary reciprocating files with that of Pro-Taper system files.

METHODOLOGY

Forty sample teeth were used inserted in a plaster of paris rectangular block. Each canal was injected with ink using a syringe. In each block, landmarks were placed 3 mm from the 4 corners of the side of interest. Images were taken by a digital camera (Nikon D70) positioned centrally and at 90 degrees to the specimen. Digital images of all specimens before instrumentation were obtained and saved as JPEG files. Specimens were then randomly assigned to 2 different groups (n = 20 each). In group 1, the glide path was created with PathFile 1, 2, and 3 ;at the full working length (WL) using Glyde as the lubricating agent. Each canal was shaped using Pro- Taper S1-S2, and then the WL was checked. Canal patency was checked with a #10 K-file before the glide path, after the glide path, before using ProTaper S1, and after ProTaper S2. In group 2, Canals were shaped with WaveOne Primary reciprocating files using a pecking motion. The WL was checked when the instrument had reached the limit between the middle and apical third, and then shaping was accomplished at that the definitive WL. Canal patency was checked with a #10 K-file before the glide path, after the glide path, and before using WaveOne Primary, and when WaveOne Primary had reached the limit between the middle and the apical third before completing shaping at the full WL. In particular, an arc corresponding to 45 degrees was considered for the optimal fit algorithm, and the correlation coefficients were larger than 99.99%. By considering the fitted osculating circles, both the curvature radius of each initial canal (CRi) and the curvature radius of the corresponding final canal (CRf) were obtained, and the geometric parameter called the curvature-radius ratio (CRr) was computed for each canal as CRr = 100 * CRf/CRi. The closer the CRr parameter is to the value 100, the smaller the canal shape modifications caused by the instrumentation. Another geometric parameter identified as the relative axis error (rAe) was computed in order to better investigate canal modifications induced by instrumentation. In particular, to obtain the value of rAe for each canal. Therefore, the smaller the rAe, the less the canal shape had been modified by instrumentation. Two, 1-way balanced analyses of variance were performed to investigate canal modifications induced by instrumentation and evaluate the significance of the instrument factor at 2 levels (PT and W1) both on CRr and on rAe. The significance level was set to 5% ($P < .05$). All statistical analyses were performed by using SPSS package 20.

Figure 1- (A) The interval plot for the CRr parameter; 95% confidence intervals for the mean. (B) The interval plot for the rAe parameter; 95% confidence intervals for the mean.



RESULTS

The instrument factor was extremely significant for both the CRr parameter (F1 = 11.16, P = .002) and the rAe parameter (F1 = 12.18, P = .002). The interval plots for the CRr parameter (Fig. 1A) and the rAe parameter (Fig. 1B) graphically confirmed statistical significance of the instrument factor.If the instrument factor is at level WaveOne (W1), then the CRr parameter is closer to the value 100 and the rAe parameter to the value 0 (ie, if WaveOne is used, the canal modifications seem to be significantly reduced). No macroscopic deformations or fractures of any instrument, mechanical or manual, occurred during the experiment.

DISCUSSION

The WaveOne Primary has a reverse cutting blades design. They were used with the following motions: reciprocating motion for the WaveOne Primary and rotary motion for the Protaper system. Previous studies have shown that preserving the original canal shape with a less invasive approach minimizes the risk of canal transportation with a subsequently lower incidence of canal curvature straightening, the formation of ledges, and irregular apical enlargement. The prevention of apical transportation and irregular foramen widening may also lead to a well-sealed root filling with less extrusion of debris and reduced postoperative discomfort.[10] Preservation of the original canal shape and the lack of canal aberrations are associated with increased antimicrobial and sealing efficiency and reduced weakening of the tooth structure. Besides canal anatomy, other factors contribute to optimal mechanical instrumentation outcomes, such as instrument design, instrumentation sequence, rotational speed, operator's experience, and the use of irrigants. Several studies showed that the use of NiTi rotary instruments enabled more predictable and efficient canal preparation with less procedural errors, particularly in narrow and severe curved canals, compared with hand instrumentation.[11] Recently, a new WaveOne NiTi single-file reciprocating system has been introduced to simplify root canal preparation. Only one single shaping file is required to provide the canal with an adequate size and taper. The main characteristics of this system are single use, a reciprocating action, and M-Wire technology alloy manufacturing. The use of a single Pro- Taper F2 used in a reciprocating motion to reach an adequate root canal shaping has been previously investigated. On engagement with the root canal wall, the counter-clockwise rotation disengages the instrument, promoting a safer use of single-file instruments in curved canals.[12] The advantages of the reciprocating motion are based on the physics law of action and reaction applied to root canal instrumentation, which results in a balanced force, as theorized by Roane et al.[13] This concept, despite incomplete elucidation, has shown its clinical relevance in severely curved canals. The reciprocating movement minimizes torsional and flexural stresses, increases the canal centering ability, and reduces the taper lock within the number of instrument cycles within the root canal. Recent studies showed that an alternating rotary movement is a valid option to optimize endodontic instrumentation by reducing the risk of instrument fracture and root canal deformity. The use of the reciprocating motion instead of the continuous rotation method could be advantageous in terms of stresses and the time required for the preparation of curved root canals with a single use of an NiTi file. In our study, the single-file technique used with the reciprocating motion enhanced the canal centering ability, leading to less invasive root canal preparation. This outcome may be particularly significant where dentine thickness is lower.[14]

CONCLUSION

In conclusion, within the limits of this study, the new WaveOne NiTi Primary reciprocating single-file better maintained the original canal anatomy, with less modification of the canal curvature compared with the ProTaper system. Further investigations are needed to understand whether the better performance of the instrument may be attributed to the reciprocating motion, the variable section design.

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