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**Dental Education-related Report**

## **Undergraduate Students Introduction to Manual and Rotary Root Canal Instrumentation**

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### **Abstract**

The aim of this study was to evaluate the performance of undergraduates in their first contact with manual and rotary root canal instrumentation. Forty-two students who had never worked on a root canal before instrumented 42 extracted lower-incisors. Participants were assigned to one of two groups: Rotary instrumentation or manual instrumentation. Pre- and post-operative computed tomography scans were obtained with a 3-dimensional dental imaging system. Starting and finishing times of preparation were recorded. The cross-sectional area of the root canal was analyzed with 2-mm-below-the-apex initial and final transverse images recorded through a digital imaging system and analyzed with software to measure the initial and final area of the root canal in mm<sup>2</sup>. Data from the cross-sectional area of the root canal and time spent were subjected to the Mann-Whitney's U-test ( $p < 0.05$ ). The rotary instrumentation group showed smaller time for preparation ( $p = 0.0204$ ). No differences between rotary and manual instrumentation regarding the cross-sectional area of the root canal were observed ( $p = 0.25$ ). No accidents occurred. Undergraduate students showed good performance in their first contact with the manual and rotary instrumentation with regard to time spent and cross-sectional area of the root canal, with no operative accidents.

**Key words:** Undergraduate students—Root canal—Manual instrumentation—  
Rotary instrumentation—Computed tomography

### **Introduction**

Major changes have been occurring at different stages of endodontic treatment. This is especially true in the preparation phase, with the introduction of different nickel and titanium (NiTi) rotary systems that have made instrumentation more efficient in terms of

speed, safety, quality and success of therapy<sup>5)</sup>.

Root canal preparation which allows a uniformly conical shape to be maintained between the apical and cervical thirds is the gold standard<sup>17)</sup>. Currently, preparation based on the concept of “crown-down” is widely used and allows the creation of a tapered root canal<sup>11,12)</sup>, with additional advantages such as

a better definition of the apical stop due to the prior elimination of dentin interferences located in the cervical and medium thirds. Thus, direct access to the apical third is obtained and this area may be prepared and cleaned while its anatomy is respected<sup>15)</sup>. The popularity of the “crown-down” has increased with the continuing development of the NiTi rotary systems usually employed with this method.

The employment of NiTi rotary systems involves the development of tactile sensitivity. Due to the use of a hand piece for powering the instruments, the operator may experience decreased contact sensitivity with the dentin walls, which requires mastering the technique. In manual instrumentation, on the other hand, contact sensitivity with the root canal walls is higher. However, the technician must also be well trained since technical ability is required for good performance.

It is widely accepted that NiTi rotary systems have revolutionized root canal preparation, promoting more adequate formats, centralized preparations, less extrusion of debris towards the apical region, as well as faster preparation<sup>8)</sup>. Most studies have evaluated the performance of these systems as used by experienced professionals<sup>10)</sup>. However, many general practitioners have little experience of performing endodontic treatment with mechanical instrumentation<sup>6,13)</sup>.

Although NiTi rotary systems are widely used, not all universities teach this kind of instrumentation in undergraduate programs. The resistance to teaching rotary instrumentation to undergraduate students is mainly related to the fear that the student will not be able to do it properly and the possibility of instrument fractures, since the student might not be able to properly control the movement of the instrument rotating 360° inside the root canal<sup>22)</sup>. Few studies have assessed the ability of undergraduate students with no previous experience with endodontic instrumentation comparing manual and rotary techniques<sup>6,22)</sup>. Therefore, the aim of this study was to evaluate the performance of undergraduates in their first contact with manual and rotary root

canal instrumentation in relation to the cross-sectional area of the root canal, time spent in preparation and occurrence of accidents.

## Materials and Methods

This research involved 42 second-year dental students inexperienced in pre-clinical endodontics at the School of Dentistry of the Positivo University, Curitiba, Paraná, Brazil. Four professors of the discipline had previously selected 42 extracted lower incisors of approximately 21 mm with a single root canal, confirmed by radiographs taken in the mesio-distal direction. Once selected, the samples were placed in individual vials containing distilled water to maintain the humidity of the dentin. Teeth were used with the approval of the Ethics Committee of Positivo University (no.006/11).

Each student received an extracted lower incisor. At this point, these students had only attended lectures on root canal anatomy, manual and rotary instruments and techniques and had never instrumented a root canal. On the day of the experiment, in addition to the recommendations given by the professors, each student followed a 2-hr theoretical lecture and received a printed script with step-by-step instructions on both manual and rotary root canal instrumentation. The 42 students were randomly assigned to one of two groups of 21 students each: Group I, rotary instrumentation; Group II, manual instrumentation.

To record the pre- and post-operative conditions of the root canal, cone beam computed tomography (CBCT) scans were obtained before and after preparation using an iCat Cone Beam 3D Dental Imaging System (Imaging Sciences International, Hatfield, Pennsylvania, USA). The following parameters were defined: pixel size = 0.20 mm, capturing 6 for 40 cm FOV sec = 120.00 kVp, mAs = 36.12.

After the initial CBCT, the teeth were distributed to students with initial radiographies, coronal access and working length at 1 mm already made and determined by the profes-

Table 1 Mean values and standard deviations (in parenthesis) of cross-sectional area of root canal and time taken to prepare root canals by type of instrumentation employed

|           | Rotary instrumentation               | Manual instrumentation               |
|-----------|--------------------------------------|--------------------------------------|
| Mean area | 0.497 mm <sup>2</sup> ( $\pm 0.36$ ) | 0.471 mm <sup>2</sup> ( $\pm 0.49$ ) |
| Mean time | 21.2 min ( $\pm 10.0$ )              | 25.4 min ( $\pm 9.2$ )               |

sors. Group I performed manual instrumentation with Flexofile and K-type stainless steel files (Dentsply-Maillefer, Ballaigues, Switzerland). Group II performed rotary instrumentation with the NiTi instrument Profile.04 (Dentsply-Maillefer, Ballaigues, Switzerland) driven by a pneumatic hand piece with a reduction of 64:1 (Anthogyr, Sallanches, France). Both preparations were previously complemented by use of Gates-Glidden drills #1–4 (Dentsply-Maillefer, Ballaigues, Switzerland) in the cervical and middle thirds. In both groups, the samples were instrumented using a crown-down technique, starting with a #60 instrument and irrigating the root canals with 3 ml, 2.5% NaOCl solution at each change of file. Final irrigation was performed with 17% EDTA for 5 min.

Students in both groups were constantly advised by the professors regarding the movement kinematics of either technique (traditional movement kinematics of 1/4 to 1/2 clockwise to manual and peck motion for rotary). The apical preparation was made until #45 instrument in the manual group and #45.04 in the rotary instrumentation group. After completing apical preparation, a radiograph was obtained with either instrument #45.02 or #45.04 into the root canal to confirm the preparation and determine whether any working accidents such as instrument fracture, step formation or loss of working length had occurred. The CBCT scans were also used to evaluate whether any root canal deformation had occurred.

The analysis of CBCT transverse images was made at a 2 mm distance from the apex through the iCAT Vision software (Imaging Sciences International, Hatfield, Pennsylvania, USA). The images were stored in JPEG

format and analyzed with the Image Tool 3.0 software (UTHSCSA, San Antonio, Texas, USA). Cross-sectional areas of the root canal in mm<sup>2</sup> were obtained and differences between initial and final areas calculated, showing if the area had increased. The time for preparation of each student was recorded with a digital timer (PC396, Insight Equipamentos, Ribeirao Preto, Brazil) and post-operative CBCT performed. Data on the cross-sectional area of the root canal and time spent in each group were subjected to the Mann-Whitney's U-test ( $p < 0.05$ ).

## Results

Regarding time, the rotary instrumentation group, as expected, showed smaller time for preparation and the difference between the two groups was statistically significant ( $p = 0.0204$ ). Regarding the cross-sectional area of the root canal, the rotary instrumentation (Group II) showed no statistically significant difference compared to manual instrumentation (Group I,  $p = 0.2485$ ). The analysis of pre- and post-operative cross-sectional area showed that preparation followed the original root canal shape. Table 1 shows the data for each group in relation to the cross-sectional area of the root canal and time spent for preparation.

Regarding accidents, no instrument fractures, steps or deviations occurred in either group.

## Discussion

Although students from different universi-

ties accept the use of rotary instrumentation<sup>2,9)</sup>, the utilization of this technique in undergraduate programs is not yet the norm, as many universities still resist its inclusion in the teaching of endodontics. At Positivo University, however, the situation is different, and the endodontics program has taught and required knowledge of the characteristics of manual and rotary instruments and their mode of employment since 2005. The use of NiTi rotary instruments has advantages related to the reduction of working time, as observed in the present study and scientific literature<sup>21)</sup>. These instruments have higher taper, allowing creation of a more favorable preparation with a conical shape<sup>20)</sup>. On the other hand, when stainless steel manual files are used, the quality of the preparation may be compromised, and the preparation may not have good taper, especially in narrow and curved canals<sup>16)</sup>. Moreover, stainless steel instruments are more rigid and when used in curved root canals the chance of complications such as steps and zips is higher<sup>23)</sup>. Curved canals were not used in this study, as the aim was to evaluate the influence of lack of experience in undergraduate students in regards to instrumentation, and the effect of anatomical variations such as apical curvature in root canal preparation was not assessed.

In the present study, no complications such as fractures, formation of steps, zips or loss of working length were observed in either group. This was because incisors without sharp apical curvature were employed and the preparation was geared toward a crown-down approach. Although the preparation was geared toward the widely used crown-down approach<sup>4)</sup>, however, the cross-sectional area of the root canal prepared with rotary instruments was not statistically significant different to that obtained with manual instrumentation, even though rotary instruments have higher taper (0.04) than manual instruments (0.02). It is important to note that a larger root canal area is expected after preparation with the aim of cleaning, shaping and filling, although aggressive dentin removal through greater-tapered instrumentation did

not reduce intracanal bacteria more efficiently than a more conservative instrumentation technique<sup>3)</sup>. Only the apical third was chosen in this study because frequently studies show that this is the most difficult area to clean and shape<sup>15)</sup>. In this study, the root canals were instrumented with a working length of 1 mm from the apex. It is believed that a working length 1 mm short of the tooth foramen generates less cracks at the apical surface<sup>1)</sup>.

Regarding the time spent for preparation, as expected, rotary instrumentation was faster than manual, and the difference was statistically significant. Other studies also reported a higher speed with rotary instrumentation when performed by inexperienced students<sup>7,14,19,22)</sup>. This greater speed is due to the difference in design of these two types of instrumentation. Rotary instruments can turn 360° in the root canal, facilitating the cut of dentin and quicker preparation.

In the present study, Profile.04 rotary instruments were chosen as they are routinely used in universities<sup>18)</sup> and in the endodontics program of this institution, and because they have a diameter of D<sub>0</sub>, which is equivalent to that of manual instruments, making it possible to match manual files and rotary instruments and facilitating the understanding of techniques by students.

According to the results of the present study, students with no experience in endodontic treatment are able to safely employ rotary instrumentation early in their apprenticeship in endodontics, producing an enlargement of the root canal consistent with current principles and faster than with manual technique.

The results of the present study showed that undergraduate students performed well with regard to the cross-sectional area of the root canal with either manual or rotary instrumentation in their first experience of root canal preparation. Rotary instrumentation was significantly faster than manual and no accidents occurred with either technique.

## References

- 1) Adorno CG, Yoshioka T, Suda H (2011) Crack initiation on the apical root surface caused by three different nickel-titanium rotary files at different working lengths. *J Endod* 37:522–525.
- 2) Arbab-Chirani R, Vulcain JM (2004) Undergraduate teaching and clinical use of rotary nickel-titanium endodontic instruments: a survey of French dental schools. *Int Endod J* 37:320–324.
- 3) Aydin C, Tunca YM, Senses Z, Baysallar M, Kayaoglu G, Orstavik D (2007) Bacterial reduction by extensive versus conservative root canal instrumentation *in vitro*. *Acta Odontol Scand* 65:167–170.
- 4) Bird DC, Chambers D, Peters OA (2009) Usage parameters of nickel-titanium rotary instruments: a survey of endodontists in the United States. *J Endod* 35:1193–1197.
- 5) Cheung GS, Liu CS (2009) A retrospective study of endodontic treatment outcome between nickel-titanium rotary and stainless steel hand filing techniques. *J Endod* 35:938–943.
- 6) Gekelman D, Ramamurthy R, Mirfarsi S, Paque F, Peters OA (2009) Rotary nickel-titanium GT and ProTaper files for root canal shaping by novice operators: a radiographic and micro-computed tomography evaluation. *J Endod* 35:1584–1588.
- 7) Gluskin AH, Brown DC, Buchanan LS (2001) A reconstructed computerized tomographic comparison of Ni-Ti rotary GT files versus traditional instruments in canals shaped by novice operators. *Int Endod J* 34:476–484.
- 8) Kosa DA, Marshall G, Baumgartner JC (1999) An analysis of canal centering using mechanical instrumentation techniques. *J Endod* 25: 441–445.
- 9) Leonardi DP, Baratto-Filho F, Haragushiku GA, Tomazinho FSF, Lopes MGK, Moro A (2011) Undergraduates' opinion after 5-year experience with rotary endodontic instruments. *RSBO* 8:68–74.
- 10) Metzger Z, Zary R, Cohen R, Teperovich E, Paque F (2010) The quality of root canal preparation and root canal obturation in canals treated with rotary versus self-adjusting files: a three-dimensional micro-computed tomographic study. *J Endod* 36:1569–1573.
- 11) Morgan LF, Montgomery S (1984) An evaluation of the crown-down pressureless technique. *J Endod* 10:491–498.
- 12) Palmer NO, Ahmed M, Grieverson B (2009) An investigation of current endodontic practice and training needs in primary care in the north west of England. *Br Dent J* 206:E22; discussion 584–585.
- 13) Parashos P, Messer HH (2004) Questionnaire survey on the use of rotary nickel-titanium endodontic instruments by Australian dentists. *Int Endod J* 37:249–259.
- 14) Peru M, Peru C, Mannocci F, Sherriff M, Buchanan LS, Pitt Ford TR (2006) Hand and nickel-titanium root canal instrumentation performed by dental students: a micro-computed tomographic study. *Eur J Dent Educ* 10:52–59.
- 15) Riitano F (2005) Anatomic Endodontic Technology (AET)—a crown-down root canal preparation technique: basic concepts, operative procedure and instruments. *Int Endod J* 38:575–587.
- 16) Schafer E, Tepel J, Hoppe W (1995) Properties of endodontic hand instruments used in rotary motion. Part 2. Instrumentation of curved canals. *J Endod* 21:493–497.
- 17) Schilder H (1967) Filling root canals in three dimensions. *Dent Clin North Am*:723–744.
- 18) Shen Y, Coil JM, Haapasalo M (2009) Defects in nickel-titanium instruments after clinical use. Part 3: a 4-year retrospective study from an undergraduate clinic. *J Endod* 35:193–196.
- 19) Sonntag D, Delschen S, Stachniss V (2003) Root-canal shaping with manual and rotary Ni-Ti files performed by students. *Int Endod J* 36:715–723.
- 20) Steffen H, Löw A, Rosin M, Welk A (2006) Comparison of K hand files and ProFiles 0.06/0.04 in simulated curved root canals prepared by students. *Quintessence Int* 37: 811–817.
- 21) Thompson SA, Dummer PM (1998) Shaping ability of Quantec Series 2000 rotary nickel-titanium instruments in simulated root canals: Part 1. *Int Endod J* 31:259–267.
- 22) Tu MG, Chen SY, Huang HL, Tsai CC (2008) Endodontic shaping performance using nickel-titanium hand and motor ProTaper systems by novice dental students. *J Formos Med Assoc* 107:381–388.
- 23) Yang GB, Zhou XD, Zhang H, Wu HK (2006) Shaping ability of progressive versus constant taper instruments in simulated root canals. *Int Endod J* 39:791–799.

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