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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 mm². 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. Root canal preparation which allows a uniformly conical shape to be maintained between the apical and cervical thirds is the gold standard. Currently, preparation based on the concept of “crown-down” is widely used and allows the creation of a tapered root canal, 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\(^\text{(5)}\)
. 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, central-
ized preparations, less extrusion of debris
towards the apical region, as well as faster
preparation\(^\text{(8)}\) . Most studies have evaluated
the performance of these systems as used by
experienced professionals\(^\text{(10)}\) . However, many
general practitioners have little experience
of performing endodontic treatment with
mechanical instrumentation\(^\text{(13)}\) .

Although NiTi rotary systems are widely
used, not all universities teach this kind of
instrumentation in undergraduate programs.
The resistance to teaching rotary instrumen-
tation to undergraduate students is mainly
related to the fear that the student will not
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 \(360^\circ\) inside the root
canal\(^\text{(22)}\) . Few studies have assessed the ability
of undergraduate students with no previous
experience with endodontic instrumentation
comparing manual and rotary techniques\(^\text{(6,22)}\).

Therefore, the aim of this study was to evalu-
ate 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 previ-
ously 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 tech-
niques and had never instrumented a root
canal. On the day of the experiment, in addi-
tion to the recommendations given by the
professors, each student followed a 2 hr theo-
retical 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 condi-
tions 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 (Imag-
ning Sciences International, Hatfield, Pennsyl-
vania, 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 dis-
tributed to students with initial radiographies,
coronal access and working length at 1 mm
already made and determined by the profes-
Rotary Instrumentation in Undergraduates

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 cross-sectional 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 were obtained in mm² 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-

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<td>Mean area</td>
<td>0.497 mm² (± 0.36)</td>
<td>0.471 mm² (± 0.49)</td>
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<td>Mean time</td>
<td>21.2 min (± 10.0)</td>
<td>25.4 min (± 9.2)</td>
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ties accept the use of rotary instrumentation\textsuperscript{2,9}, 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\textsuperscript{21}. These instruments have higher taper, allowing creation of a more favorable preparation with a conical shape\textsuperscript{20}. 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\textsuperscript{18}. 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\textsuperscript{23}. 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\textsuperscript{4}, 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\textsuperscript{5}. Only the apical third was chosen in this study because frequently studies show that this is the most difficult area to clean and shape\textsuperscript{15}. 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\textsuperscript{1}.

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\textsuperscript{7,14,19,22}. 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\textsuperscript{18} and in the endodontics program of this institution, and because they have a diameter of D0, 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


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