

# Introduction of nickel titanium rotary instruments to undergraduate students: a four-year clinical experience

Gabrielle Maria de Lima de Oliveira\*; Natanael Henrique Ribeiro Mattos\*\*; Liliane Roskamp\*\*;  
Allan Abuabara\*\*\*; Flares Baratto-Filho\*\*\*\*; Maria Carolina Botelho Pires de Campos\*; Camila  
Paola da Costa Xavier\*; Camila Paiva Perim\*\*

\* Undergraduate student, Department of Dentistry, Universidade Tuiuti do Paraná

\*\* Professor, Department of Dentistry, Universidade Tuiuti do Paraná

\*\*\* DDS, Healthcare Division, Joinville Municipal Authority

\*\*\*\* Professor, Department of Dentistry, Universidade Tuiuti do Paraná and Department of Dentistry, Universidade da Região de Joinville

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## ABSTRACT

Many studies address the quality of root canal treatments, but few refer to endodontics using rotatory techniques performed by novice operators. This study evaluated the performance of undergraduates in their first contact with rotary root canal instrumentation concerning the findings of the final periapical radiograph, and the post endodontic treatment pain. A longitudinal observational study was performed on periapical radiographs of 491 teeth from 450 patients submitted to root canal treatment by undergraduate students from 2015 to 2018. The analysis of the length of root canal filling followed the criteria: (i) acceptable, if periapical radiograph presents root filling ending 0 - 1 mm short of radiographic apex; (ii) over, if periapical radiograph presents root filling ending beyond the radiographic apex; and (iii) under, if periapical radiograph presents root filling ending > 1 mm short of radiographic apex. Evaluation of postendodontic treatment pain was categorized into either absence or presence of pain. Adequate length root canal filling was observed in 65.9% of the cases (324 teeth). Periapical lesions presence and dimensions did not interfere to the obturation quality. Statistical relation was found between the pulp condition and postendodontic treatment pain. The presence of pain was observed in 4.7% of the vital teeth and 0.3% of non-vital teeth. The presence of periapical lesion did not influence postoperative pain. Adequate length root canal filling was observed in most cases and NitTi rotary instrumentation had applicability in undergraduate programs, even with novice operators. Besides that, pulp condition had an effect on postendodontic pain.

**Descriptors:** Endodontics. Undergraduate. Root Canal Preparation.

## 1 INTRODUCTION

Improvement in understanding the etiology of endodontic pathology and significant

technological advances, such as cone beam computed tomography and rotary systems, have been changing the teaching of root canal

treatment. The nickel and titanium (NiTi) rotary systems revolutionized the endodontic treatment promoting faster and more adequate root canal preparations and less extrusion of debris towards the apical region<sup>1,2</sup>. Most of the undergraduate endodontic education in the UK and Spanish trainee their students to use rotary instruments<sup>3,4</sup>. In other countries, such as Brazil, Malaysia and Saudi Arabia, the schools are introducing this kind of instrumentation in undergraduate programs<sup>5-7</sup>. In Brazil, the National Curriculum Guidelines have the proposal of training critical, reflective, human individuals, capable of understanding patients as a whole in addition to being qualified for general practice<sup>8</sup>. In essence, it targets potential professionals for the public health service<sup>8</sup>, where rotary instrumentation is already used.

Endodontic treatment outcome is routinely judged by clinical signs and symptoms, complemented by radiographic evaluation. Obturation density is considered adequate if the root filling is homogenous with no visible voids within or between the filling and the root walls. Obturation level, positioned within 2 mm of the radiographic apex (0 to 2 mm) is considered satisfactory<sup>9-12</sup>.

Although many studies address the quality of root canal treatments, few are published about endodontics using rotatory techniques performed by novice operators. Thus, the aim of this study was to evaluate the performance of undergraduates in their first contact with rotary root canal instrumentation concerning the findings of the final periapical radiograph. Postendodontic treatment pain according to the pulpal status and the presence of periapical lesion also was examined.

## 2 METHODS

The Ethics Committee in Human Research of the Universidade Tuiuti do Paraná approved

this study by the process number 772157.7.0000.8040. All data regarding patients' information remained confidential and was assessed only for study purposes.

A collection of 450 dental patient records that include information on 491 endodontic treatments performed at the School of Dentistry, Universidade Tuiuti do Paraná, between 2015 and 2018, was investigated. The inclusion criteria were (a) root canal treatment carried out by fifth-year undergraduate students – with 16-hour preclinical training – on completely formed teeth; (b) mechanical preparation using nickel and titanium rotatory root canal instrumentation; and (c) good quality of the final periapical radiography, allowing to identify the filling root canal limit and periapical condition, as evaluated by an experienced professor. Exclusion criteria were endodontic retreatment and dental records with insufficient data about the endodontic treatment and pain.

The analysis of the length of root canal filling followed the criteria: Acceptable - periapical radiograph presenting root filling ending 0 - 1 mm short of radiographic apex; Over - periapical radiograph showing root filling ending beyond the radiographic apex; or Under - periapical radiograph presenting root filling ending > 1 mm short of radiographic apex.

Evaluation of postoperative pain was categorized into either absence or presence of pain regardless of the intensity of pain experienced by the patient. All patients were contacted by telephone after 24 hours to check postoperative status. In cases of persistent symptomatology, patients were requested to return to the clinic for management of the symptoms.

Data was tabulated on Excel 2016 (Microsoft, Redmond, WA, USA) and analyzed using statistical software Stata/SE v.14.1. (Stata Corp LP, College Station, TX, USA). Chi-square and Fisher's exact tests were performed to

investigate associations between variables of interest. The statistical significance was set at  $\alpha=0.05$ .

## RESULTS

The most prevalent teeth were molar (44.2%) followed by premolar (34.0%), incisor (16.3%) and canine (5.5%) (table 1). Adequate length root canal filling was observed in 324 teeth (65.9%). Table 1 shows the length of the root canal filling in association to each group by tooth. A significant difference ( $p < 0.05$ ) was

observed in the acceptable root fillings group.

Tables 2 and 3 shows that the presence and dimensions of periapical lesion did not interfere the obturation quality. In this analysis, only non-vital cases were considered, that represents 321 teeth (65.3%).

Statistical relation was found between the pulp condition and postendodontic treatment pain. The presence of pain was observed in 4.7% of the vital teeth and 0.3% of non-vital teeth (table 4). Also, the presence of periapical lesion did not influence postoperative pain (table 5).

Table 1. Acceptable and unacceptable root fillings according to the location

Obturation quality	Tooth			
	Incisor	Canine	Molar	Premolar
Accept (0-1mm)	62 77.5%*	18 66.7%*	139 64.1%*	105 62.9%*
Under (> 1mm)	14 17.5%	8 29.6%	57 26.3%	56 33.5%
Over (extrusion)	4 5.0%	1 3.7%	21 9.7%	6 3.6%
<b>Total</b>	<b>80</b> <b>16.3%</b>	<b>27</b> <b>5.5%</b>	<b>217</b> <b>44.2%</b>	<b>167</b> <b>34.0%</b>

\*p value: 0.037 (chi-square test,  $p < 0.05$ )

Table 2. Acceptable and unacceptable root fillings according to the presence of periapical lesion

Obturation quality	Periapical lesion (only non-vital)	
	No	Yes
Accept (0-1mm)	93 64.1%	123 69.9%
Under (> 1mm)	39 26.9%	40 22.7%
Over (extrusion)	13 9.0%	13 7.4%
<b>Total</b>	<b>145</b>	<b>176</b>

p value: 0.550 (chi-square test,  $p < 0.05$ )

Table 3. Acceptable and unacceptable root fillings according to the dimensions of the periapical lesion

Obturation quality	Dimensions of periapical lesion		
	Small < 10 mm	Medium 10-20 mm	Large > 20 mm
Accept (0-1mm)	74 66,7%	40 78.4%	9 64.3%
Under (> 1mm)	29 26.1%	9 17.6%	2 14.3%
Over (extrusion)	8 7.2%	2 4.0%	3 21.4%
<b>Total</b>	<b>111</b>	<b>51</b>	<b>14</b>

p value: 0.141 (chi-square test,  $p < 0.05$ )

Table 4. Postoperative pain according to the pulpal status

Pain	Vital or non-vital	
	Vital	Non-vital
Pain free	162 95.3%	320 99.7%
Presence of pain	8 4.7%*	1 0.3%*
<b>Total</b>	<b>170</b>	<b>321</b>

\*p value: 0.001 (Fisher's exact test,  $p < 0.05$ )

Table 5. Postoperative pain according to the presence of periapical lesion

Pain	Periapical lesion (only non-vital)	
	No	Yes
Pain free	145 100%	175 99.4%
Presence of pain	0 0%	1 0.6%
<b>Total</b>	<b>145</b>	<b>176</b>

p value: 1 (Fisher's exact test,  $p < 0.05$ )

### 3 DISCUSSION

NiTi rotary instruments were first introduced to the market during the mid-1990s<sup>13</sup>. The advantages of using NiTi rotary instruments

are well described, such as quality, efficiency, comfort, and safety for both dentists and patients<sup>14</sup>. However, thirty years later, in some countries many dental schools still resist its

inclusion in the teaching of endodontics in undergraduate programs<sup>5</sup>.

Georgelin-Gurgel et al.<sup>15</sup> and Alrahabi<sup>16</sup> concluded that manual instrumentation is safer than rotary instrumentation in the hands of inexperienced students. According to the authors, acquiring skills in the use of NiTi rotary instrumentation requires specific preclinical training to avert file breakage and loss of working length. In contrast, the results of this study suggest that theoretical and practical endodontic teaching in undergraduate programs could be rethought, introducing rotary instruments.

A five-year experience in rotary technique teaching at a private university in Brazil was considered excellent since the undergraduates demonstrated a great level of acceptance of the new technique<sup>17</sup>. Faster root canal preparation and reduction of patient's stress were highlighted as advantages<sup>17</sup>. Epidemiological data on the quality of root fillings completed by undergraduate students in different countries ranged between 13% and 63%<sup>17</sup>. Khabbaz et al.<sup>18</sup> found acceptable root fillings in 55% of canals treated by fourth and fifth-year undergraduate students using stainless steel hand instruments. According to the present results, students with no experience in endodontic treatment are able to safely employ rotary instrumentation presenting adequate length root canal filling in 65.9% of the treatments. This is a remarkable finding, but we believe that exists a potential to reach better results using rotatory instruments yet during de graduation teaching. In Brazil, the National Curriculum Guidelines targets potential professionals for the public health service<sup>8</sup>, where rotary instrumentation is already a reality in some health units, indicating the approach of these techniques in under graduation.

In terms of postendodontic treatment

pain, this study revealed that there was significant difference between vital and non-vital teeth. Presence of pain was observed in 4.7% of the vital teeth and only 0.3% of non-vital teeth. This is in accordance with Gotler et al.<sup>19</sup> who concluded that teeth with vital pulp was associated with a higher incidence and intensity of postendodontic treatment pain. The reason for the higher incidence of postendodontic treatment pain after treatment of teeth with vital pulp is not completely clear. One possibility is that the injury of periapical vital tissue during endodontic treatment in teeth with vital pulp promotes more intensive secretion of inflammatory mediators<sup>19</sup>. Another factor that can contribute to the higher frequency of postendodontic treatment pain is if the root canal treatment was performed at a single visit which was not evaluated in this study. According to the literature, single-visit treatment has been resulted in higher frequency of postendodontic treatment pain<sup>20</sup>. The low rate of postendodontic pain stands out in this study even with novice operators. The NiTi rotary systems which promote faster and more adequate root canal preparations and less extrusion of debris towards the apical region may be the reason for this result. Using hand instrumentation, Gotler et al.<sup>19</sup> observed incidence of 63.8% of postendodontic treatment pain of teeth with vital pulp and 38.5% of teeth with necrotic pulp. In contrast with our results, Çiçek et al.<sup>21</sup> reported lower incidence of postendodontic treatment pain in the group of patients submitted to the endodontic treatment with hand files than the group treated with rotary files. The effect of instrumentation techniques on the incidence of postoperative pain should be further evaluated.

Schools are moving towards more contemporary endodontic practice with the use of rotary or reciprocating instruments<sup>3</sup>. It is true that this study has limitations because only the length root canal filling was evaluated. Density and

taper of root canal filling were not evaluated. Yet, other studies also support our results<sup>5,17,22-24</sup>. Arbab-Chirani and Vulcain<sup>24</sup>, in 2004, reported that there was a national consensus over the need for undergraduate teaching of rotary NiTi systems in France. According the authors, these techniques had made a substantial impact in endodontic teaching and were widely taught and used in French dental schools. In German, in 2008, 63% of the universities taught root canal preparation with rotary NiTi instruments<sup>25</sup>. United Kingdom and Spanish dental schools already use both rotary and reciprocating instrumentation systems during endodontic training<sup>3,4</sup>. Within the limitations of this study, NitTi rotary instrumentation is viable and has applicability in undergraduate programs, even with novices.

## CONCLUSION

Adequate length root canal filling was observed in 65.9% of the tooth. Root canal treatment of teeth with vital pulp induced a significantly higher incidence of postendodontic treatment pain (4.7%) when compared to treatment of teeth with necrotic pulp (0.3%).

## RESUMO

### **Introdução de instrumentos rotários de níquel titânio para alunos de graduação: quatro anos de experiência clínica**

Muitos estudos abordam a qualidade dos tratamentos de canal radicular, mas poucos se referem à endodontia por meio de técnicas rotatórias realizada por operadores novatos. Este estudo avaliou o desempenho de graduandos no primeiro contato com a instrumentação endodôntica em relação aos achados da radiografia periapical final e à dor pós-tratamento endodôntico. Um estudo observacional longitudinal foi realizado em radiografias periapicais de 491 dentes de 450 pacientes submetidos a tratamento endodôntico por estudantes de graduação no período de 2015

a 2018. A análise do comprimento da obturação de canais radiculares obedeceu aos critérios: (i) aceitável, se a radiografia periapical apresentasse término de obturação 0 - 1 mm aquém do ápice radiográfico; (ii) acima, se a radiografia periapical apresentasse obturação que termina além do ápice radiográfico; e (iii) abaixo, se a radiografia periapical apresentasse obturação, terminando > 1 mm aquém do ápice radiográfico. A avaliação da dor pós-operatória foi categorizada em ausência ou presença de dor. A obturação de canais radiculares de comprimento adequado foi observada em 65,9% dos casos (324 dentes). A presença e as dimensões das lesões periapicais não interferiram na qualidade da obturação. Foi encontrada relação estatística entre a condição pulpar e a dor pós-tratamento endodôntico. Presença de dor foi observada em 4,7% dos dentes vitais e 0,3% dos não vitais. A presença de lesão periapical não influenciou na dor pós-operatória. O comprimento de trabalho adequado foi observado na maioria dos casos e a instrumentação rotatória NitTi teve aplicabilidade em programas de graduação, mesmo com operadores iniciantes. Além disso, a condição pulpar afetou a dor pós-operatória.

**Descritores:** Endodontia. Graduação. Preparo do Canal Radicular.

## REFERENCES

1. Kosa DA, Marshall G, Baumgartner JC. An analysis of canal centering using mechanical instrumentation techniques. *J Endod.* 1999;25(6):441-5.
2. Cheung GS, Liu CS. A retrospective study of endodontic treatment outcome between nickel-titanium rotary and stainless steel hand filing techniques. *J Endod.* 2009;35(7):938-943.
3. Al Raisi H, Dummer PMH, Vianna ME. How is Endodontics taught? A survey to evaluate undergraduate endodontic teaching in dental schools within the United Kingdom. *Int Endod J.* 2019;52(7):1077-1085.
4. Segura-Egea JJ, Zarza-Rebollo A, Jiménez-

- Sánchez MC, Cabanillas-Balsera D, Areal-Quecuty V, Martín-González J. Evaluation of undergraduate Endodontic teaching in dental schools within Spain. *Int Endod J*. 2021 Mar;54(3):454-463.
5. Leonardi DP, Haragushiku GA, Tomazinho FS, Furuse AY, Volpato L, Baratto-Filho F. Undergraduate students introduction to manual and rotary root canal instrumentation. *Bull Tokyo Dent Coll*. 2012;53(3):155-9.
  6. Narayanaraoapeta U, Alshwaimi E. Preclinical endodontic teaching. A survey of Saudi dental schools. *Saudi Med J*. 2015;36(1):94-100.
  7. Baharin SA, Omar SH. Undergraduate endodontic clinical training in Malaysia: A National survey. *Eur J Dent Educ*. 2021 Feb;25(1):168-174.
  8. Carvalho CS, Lobachinski KC, Gaião MAGS, Schmitt EJ, Caldarelli PG, Gabardo MCL. Internship in public health services: dental students' perceptions and consonance with curricular proposals. *Rev Abeno* 2021;21(1):977-989.
  9. Swartz DB, Skidmore AE, Griffin JA Jr. Twenty years of endodontic success and failure. *J Endod*. 1983;9(5):198-202.
  10. Wu MK, Wesselink PR, Walton RE. Apical terminus location of root canal treatment procedures. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2000;89(1):99-103.
  11. Schaeffer MA, White RR, Walton RE. Determining the optimal obturation length: a meta-analysis of literature. *J Endod*. 2005;31(4):271-4.
  12. Vukadinov T, Blažić L, Kantardžić I, Lainović T. Technical quality of root fillings performed by undergraduate students: a radiographic study. *ScientificWorldJournal*. 2014;28;2014:751274.
  13. Kuzekanani M. Nickel-Titanium Rotary Instruments: Development of the Single-File Systems. *J Int Soc Prev Community Dent*. 2018;8(5):386-390.
  14. Bruno FA, Nunes E, Horta MC, da Fonseca AM, Silveira FF. Importance of rotary systems in dental care by undergraduate students in patients of a public health service of Belo Horizonte. *J Clin Exp Dent*. 2016;8(1):e60-e63.
  15. Georgelin-Gurgel M, Devillard R, Lauret ME, Diemer F, Calas P, Hennequin M. Root canal shaping using rotary nickel-titanium files in preclinical teaching. *Odontostomatol Trop*. 2008;31(121):5-11.
  16. Alrahabi M. Comparative study of root-canal shaping with stainless steel and rotary NiTi files performed by preclinical dental students. *Technol Health Care*. 2015;23(3):257-265.
  17. Leonardi DP, Baratto-Filho F, Haragushiku GA, Tomazinho FSF, Kfoury MG Lopes; Moro A. Undergraduates' opinion after 5-year experience with rotary endodontic instruments. *RSBO*. 2011;8(1):68-74.
  18. Khabbaz MG, Protogerou E, Douka E. Radiographic quality of root fillings performed by undergraduate students. *Int Endod J*. 2010;43(6):499-508.
  19. Gotler M, Bar-Gil B, Ashkenazi M. Postoperative pain after root canal treatment: a prospective cohort study. *Int J Dent*. 2012;2012:310467.
  20. Naito T. Single or multiple visits for endodontic treatment? *Evid Based Dent*. 2008;9(1):24.
  21. Çiçek E, Koçak MM, Koçak S, Sağlam BC, Türker SA. Postoperative pain intensity after using different instrumentation techniques: a randomized clinical study. *J Appl Oral Sci*. 2017;25(1):20-26.
  22. Martins RC, Seijo MO, Ferreira EF, Paiva SM, Ribeiro Sobrinho AP. Dental students'

- perceptions about the endodontic treatments performed using NiTi rotary instruments and hand stainless steel files. *Braz Dent J.* 2012;23(6):729-736.
23. Abu-Tahun I, Al-Rabab'ah MA, Hammad M, Khraisat A. Technical quality of root canal treatment of posterior teeth after rotary or hand preparation by fifth year undergraduate students, The University of Jordan. *Aust Endod J.* 2014;40(3):123-130.
24. Arbab-Chirani R, Vulcain JM. Undergraduate teaching and clinical use of rotary nickel-titanium endodontic instruments: a survey of French dental schools. *Int Endod J.* 2004;37(5):320-324.
25. Sonntag D, Bärwald R, Hülsmann M, Stachniss V. Pre-clinical endodontics: a survey amongst German dental schools. *Int Endod J.* 2008;41(10):863-868.

**Correspondence to:**

Flares Baratto Filho

e-mail: [fbaratto1@gmail.com](mailto:fbaratto1@gmail.com)

Universidade Tuiuti do Paraná – UTP

Rua Sydnei Antonio Rangel Santos, 238

82010-330 Curitiba/PR Brazil