Use of technology in endodontics by undergraduate dental students in a southeastern state of Brazil

Running title: The use of technology in endodontics by students

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Use of technology in endodontics by undergraduate dental students in a southeastern state of Brazil

Abstract:

Introduction: This study aimed to determine the level of incorporation of current technologies for endodontic treatment in undergraduate dentistry courses in a southeastern state of Brazil.

Methods: For data collection, a self-assessment-based online questionnaire was created using the “Google Forms” platform, consisting of 12 multiple-choice and a few open-ended questions. The questions were related to the use of current technologies for diagnosis, imaging, use of ultrasonics in endodontics, instrumentation, use of apex locator, microscopy, photodynamic therapy, and thermoplastic techniques during endodontic treatment. The questionnaire was sent to 54 dental schools in Minas Gerais. **Results:** The results show low technological incorporation during the various stages of endodontic treatment by undergraduate students in dentistry courses in Minas Gerais.

Conclusion: Despite the availability of several technologies to help perform different stages of endodontic treatment, it was observed that most universities do not teach the use of these technologies. Additional studies are needed to correlate how the lack of incorporation of these technologies could impact on the quality of the endodontic learning for undergraduate students.

Keywords: endodontics; root canal therapy; technology.

Introduction

The skills of dental professionals have become an important subject of research for understanding and effectively catering to the health needs of the society.¹ The experiences gained in new-practice scenarios can be of crucial importance for professionals in enabling them to become integrated with social realities and articulated with the challenges in oral health care, as part of the teaching and learning process in dentistry.²

In dentistry, technological innovation is directly related to research and education.³ The acquisition of new technologies by dental schools does not necessarily indicate their implementation in clinical practice. For the implementation of a new technology, it must have some advantage, be compatible with the expected result, have low complexity, have been the object of study, and have been under observation for a requisite period.³ Rogers (2010)⁴ describes that there are four main elements in the dissemination of innovation: the innovation itself, communication channels, time, and the social system.

The success of endodontic treatment is directly related to the efficiency of root canal shaping, cleaning, and obturation, which aim to eliminate all microbial load, consequently favoring the biological healing of periradicular tissues.⁵ Besides, it is essential to establish an accurate diagnosis of the pulp or periradicular condition.⁶

The chemical-mechanical preparation of the root canal system is one of the most critical phases of endodontic treatment.^{5,7,8} New techniques and instruments have been developed for this purpose.⁹ Further, new equipment is available for use at all stages of the endodontic treatment to minimize errors and unwanted accidents, to reduce duration of the treatment, and to reduce patient exposure to radiation during radiographic examinations. This study aimed to determine the level of technological implementation in undergraduate endodontic courses in Minas Gerais.

Methodology

This study was approved by the local Research Ethics Committee, number CAAE: 79279917.1.0000.5097. It was an observational, descriptive, and cross-sectional study aimed at higher educational institutions of dentistry in Minas Gerais. The identification of the dental courses of Minas Gerais was obtained from the e-MEC register, MEC website (<http://emec.mec.gov.br/>), accessed in October 2017, February 2018, and October 2019. The data collection was performed through an online questionnaire created using the “Google forms” platform; it was a self-assessment-based questionnaire, consisting of 12 multiple-

choice and a few open-ended questions. A pilot study was conducted to develop the design of the questionnaire and validate it.

For analysis of the collected data, absolute and percentage values of the distribution were obtained, and the results were presented as descriptive statistics. The coordinators of the undergraduate courses in dentistry were informed of our research through the use of Google forms; furthermore, they also received our request for authorization to participate. Moreover, the informed consent form and questionnaire were sent to the endodontic coordinators of each institution. The questionnaires (Table 1) were adapted from the study by Sidney et al.,¹⁰ which evaluated the implementation of the use of endodontic rotary systems.

Results

Questionnaires (Table 1) were sent to the 54 institutions registered in Minas Gerais. Of these, 39 participated in the research, but only 19 answered the whole questionnaire. Seventeen institutions did not answer the questionnaire because they had not yet started the endodontic discipline during the research period. Data collection took place between February 2017 and October 2019.

Figure 1 shows the semester during which the discipline of endodontics is taught to the undergraduate students at the participating institutions. Most institutions (58%) introduced endodontics in the fifth semester.

Figure 2 depicts the frequency of usage of the Pulp Tester, a device used to conduct the pulp sensitivity test for the diagnosis of pulpal status. Only 16% of the institutions reported that they always used this technology.

Figure 3 shows the use of rotary and reciprocating instruments, and the use of the Adaptive Motion hybrid system. These were also used infrequently.

Table 2 depicts the use of microscopes among the surveyed institutions during access cavity preparation, location of calcified or obstructed root canals, retrieval of broken instruments, and endodontic retreatment. Most universities reported having never used this technology for these treatment procedures.

Table 3 shows the use of ultrasonics among the surveyed institutions during access cavity preparation, location of calcified or obstructed root canals, retrieval of broken

instruments, and endodontic retreatment. Most universities reported having never used this technology for these treatment procedures. Only two dental schools reported that they always used ultrasonic endodontic instruments during the various stages of endodontic treatment.

Table 4 shows the available technologies for use during various stages of endodontic treatment, such as digital radiography, apex locator, thermoplastic obturation system, photodynamic therapy (PDT), and passive ultrasonic irrigation (PUI). A low usage of these technologies by undergraduate students during the various stages of endodontic treatment was reported.

Discussion

The development of new techniques and innovations in dentistry has significantly contributed to the profession, improving the quality of clinical care for both professionals and patients.³ However, the incorporation of many innovations into routine clinical practice has historically been slow, with the reasons for adopting or not adopting them often being uncertain.³

According to the Brazilian Institute of Geography and Statistics (IBGE), the three most populous states in Brazil are in the Southeast. Sao Paulo occupies the top of the ranking, with 45.5 million inhabitants, equivalent to 21.8% of the country's entire population. It is followed by Minas Gerais with 853 municipalities with 21,168,791 million, and Rio de Janeiro, with 17,2 million.¹¹ The Federal Council of Dentistry (CFO) states that the largest number of dentists are in São Paulo with 98,346, followed by Minas Gerais with 38,992 and Rio de Janeiro with 32,963.¹²

The present study evaluated whether the technologies currently available in the specialty of endodontics are offered to undergraduate students in Minas Gerais dental schools. This issue is especially pertinent, given the recent increase (46%) in the number of dental schools in Minas Gerais, from 37 in 2017 to 54 in 2019. The survey results indicate that endodontics is introduced in most dental schools in the fifth and sixth semester, corresponding to the third academic year. Therefore, one of the limitations of the study was that 17 institutions which originally accepted the invitation to participate in the survey were unable to, as they had not yet started their endodontics course during the research period.

According to the results, there was a low usage of technology in endodontics by undergraduate students during the various stages of endodontic treatment. The most common reason for not using newer technologies was its unavailability at the educational institutions.

Accurate diagnosis of a condition involves thorough evaluation of objective and subjective data obtained by the professional, such as the patient's clinical and medical histories, dental and oral clinical examination, pulp sensitivity tests, and other complementary tests. The most commonly used tests for pulp diagnosis are thermal and electrical sensitivity tests that stimulate the pulp through the movement of fluid in the dentinal tubules, via changes in temperature or the application of an electric current, respectively.¹³ In this study, it was found that 42% of the surveyed universities never used the Pulp Tester, while 42% used it occasionally. Since an accurate diagnosis is crucial, the low usage of this technology needs to be questioned.

Regarding root canal instrumentation, 63% of the universities reported to have never used reciprocating systems, and 42% never used rotary systems. The advantages of this systems are the enhanced simplicity and effectiveness of the preparation, better apical control of the instruments, and better adaptation of the gutta-percha master cone during obturation, resulting in a more satisfactory obturation.⁹ The Adaptive Motion hybrid system uses both reciprocating and rotary instrumentation systems automatically during chemical-mechanical preparation. Only 5.3% of the institutions reported using this system occasionally.

The operating microscope allows the endodontist to view the root anatomy under magnification, thereby providing better conditions to perform the access cavity preparation, chemical-mechanical preparation, retreatment, treatment of perforations and removal of separated instruments, and apical surgery.¹⁴ Approximately 70% of the institutions reported to have never provided microscopes in their undergraduate curriculum, as they were unavailable..

Only 15.8% of universities reported that they used digital radiography, and 47.4% reported having never used it. The main advantages of digital radiography include the lack of requirement for chemical solutions (thus making it eco-friendly), faster processing speed, and image acuity. Digital systems also allow at least a 70% reduction in the radiation exposure dose to the patient, without altering image quality.¹⁵

Regarding the determination of working length in endodontic treatment, radiographic examination is the most commonly employed technique. However, its use is limited, as the apical constriction cannot be determined. Furthermore, variations in techniques and angles, and other factors might influence the production of a good-quality radiographic image, leading to overestimations or underestimations in the working length. The apex locator is a valid electronic method for determining working length. One of its advantages is that it optimizes the professional's working time by allowing a rapid and reliable detection of the

apical foramen location.^{16,17} Currently, there are a variety of apex locators available on the market. Even low-cost electronic locators, compared to the other traditional devices, can determine the root canal length with better accuracy and reliability.^{18,19} However, despite the advantages of using apex locators, this study showed that 21.1% of the surveyed universities have never used this device. The universities justified not using this device, citing its unavailability for undergraduate students, as well as stressing the importance of training them to use the conventional radiographic method.

The endodontic filling is intended to hermetically seal the entire root canal system with an inert or antiseptic material.^{20,21} An inadequate root canal filling is responsible for approximately 60% of endodontic failure cases.^{22,23,24} One of the best obturation outcomes results from the use of gutta-percha with a reduced amount of endodontic cement.¹³ Among the techniques available for root canal fillings, the lateral compaction technique has been practiced for over 100 years.¹³ Alternatively, thermoplastic techniques favor three-dimensional obturation of root canal systems, often sealing ramifications and apical deltas. They are of vital importance in cases of internal resorption, periradicular lesions associated with lateral canals, and accidents that occur during instrumentation such as ledges and deviations.²⁵ Even though it has been considered as an excellent technique, 78.9% of the participating universities never used thermoplastic obturation, the lateral compaction technique being the primary choice in most institutions. Conversely, Tavares et al.²⁶ stated that Tagger's hybrid technique, which uses the thermoplastic technique, was the students' preferred technique during a postgraduate course in endodontics at a university in Minas Gerais.

The use of PDT, which involves the use of a low-power laser associated with a photosensitizer activated by light at a specific wavelength, has been explored in different studies.²⁷ The advantage of this therapy is mainly related to the reduction of the microbial load in the root canal, as shown in the studies by Chrepa et al. (2014),²⁸ Amaral et al. (2019),²⁹ and Soukos et al. (2006).³⁰ The current survey found that none of the dental schools provided this apparatus for use by undergraduate students.

According to van der Sluis et al. (2007),³¹ PUI can be considered an essential supplement to traditional syringe irrigation for the cleaning of the root canal system. It removes more organic tissue, dentine debris, and planktonic bacteria from the root canal. Despite these advantages, 79% of the participating institutions never used this approach during irrigation in endodontic treatment.

A study performed in the United Kingdom³² which evaluated the delivery of undergraduate endodontic education in dental schools using an online survey, reported results that were contrary to our study. Fifteen out of 16 dental schools answered the survey (94%), representing a high level of engagement. The use of magnification, including both loupes and dental operating microscopes, was part of pre-clinical and clinical endodontic training in 33% of the schools. Ultrasonic instruments were employed in 53% of the schools for access cavity preparation, irrigation, and canal localization. During clinical training, 14 schools reported the use of both radiographs and apex locators to determine the working length. Regarding root canal instrumentation and techniques, 60% of the schools employed a rotary system, and 20% employed a reciprocating system. Similarly, to our study, lateral compaction remained the standard technique for obturation, and PDT was not mentioned by any responding schools.

The results of the present survey suggest that the use of conventional equipment and techniques in undergraduate endodontic curricula is mostly consistent across all dental schools in Minas Gerais. According to the Brazilian Federal Council of Dentistry (CFO), the number of dental schools in Brazil has grown by 87%, from 220 to 412 universities, during the last four years (2015 to 2019).³³

According to the Brazilian Dental Education Association (ABENO), in the last few years, there has been an exponential increase in the number of undergraduate courses in Dentistry in Brazil, highlighting the weaknesses that SINAES (National Higher Education Assessment System) has to identify the quality of the offer and expansion of these courses. The structure of the Dentistry undergraduate course should bring basic knowledge closer to its clinical application, through curricular integration, developed through an integrated curriculum based on interdisciplinarity and the articulation between social, biological, dental, cultural, environmental, ethnic dimensions and educational. The permanent construction of their knowledge should be based on scientific evidence and the incorporation of technological innovations in the exercise of the profession.³⁴

Despite the fact that technology plays an important role in endodontics, the lack of technology may not be an indicator of whether the school is teaching Endodontics well. According to the European Society of Endodontology, the curriculum should be presented as a list of competencies that the graduating student will be expected to have achieved. These

provide a minimum level of competence and are defined by a baseline consensus of the committee.³⁵

De Moor et al. (2013) suggested that elements of didactic teaching, pre-clinical operative techniques classes and clinical treatment of patients will contribute to the curriculum; clinical endodontics should ideally be supervised by specialists or by staff with special knowledge and interest in endodontics; specific assessment procedures should be an integral part of the curriculum in Endodontology, with both formative and summative assessment protocols; a philosophy of lifelong learning should be instilled to form an integral part of comprehensive patient care for all dental undergraduates.³⁵

Further studies should be conducted to assess if these new schools are following the ABENO guidelines,³⁴ and whether the lack of technology implementation is compromising the undergraduate learning in endodontics.

Conclusion

. Despite the wide range of technologies available to facilitate the different stages of endodontic treatment, most of the universities in this study do not teach the use of these technologies. Additional studies are needed to correlate how the lack of incorporation of these technologies could impact on the quality of the endodontic learning for undergraduate students.

Disclosure

There are no financial, economic, or professional interests influenced the design, execution or presentation of this work.

Data Availability Statement

The data that support the findings of this study are openly available in Mendeley Data repository at <http://dx.doi.org/10.17632/rmj9p3xpfy.2>, reference <https://data.mendeley.com/datasets/rmj9p3xpfy/2>

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References

1. Garbin CAS, Saliba TA, Garbin AJI, de Matos Custodio LB, Moimaz SAS. Undergraduate education in Brazil: the students' curricular perspective of dental care training. Rev ABENO. 2018;18(4):95-102.
2. Garbin CAS, Saliba NA, Moimaz SAS, Santos KT. The role of universities in the training of health professionals. Rev ABENO. 2006;6(1):6-10.
3. Parashos P, Messer HH. The diffusion of innovation in dentistry: a review using rotary nickel-titanium technology as an example. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006 Mar;101(3):395-401.

4. Rogers EM. Diffusion of innovations. 5th ed. New York: Simon and Schuster; 2010.

5. Sjögren U, Figdor D, Persson S, Sundqvist G. Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. *Int Endod J*. 1997 Sep;30(5):297-306.

6. de Medeiros JM, de Carvalho PL, Alkmin ST, Zöllner NA, Haddad Filho MS. Avaliação da escolha dos testes de sensibilidade pulpar por especialistas em endodontia. *Revista Portuguesa de Estomatologia, Medicina Dentária e Cirurgia Maxilofacial*. 2007 Jul;48(3):149-54.

7. Waltimo T, Trope M, Haapasalo M, Ørstavik D. Clinical efficacy of treatment procedures in endodontic infection control and one-year follow-up of periapical healing. *J Endod*. 2005 Dec;31(12):863-6.

8. Siqueira Jr. JF, Rôças IN. Clinical implications and microbiology of bacterial persistence after treatment procedures. *J Endod*. 2008;34(11):1291-301.

9. Ferreira F, Adeodato C, Barbosa I, Aboud L, Scelza P, Zaccaro Scelza M. Movement kinematics and cyclic fatigue of NiTi rotary instruments: a systematic review. *Int Endod J*. 2017 Feb;50(2):143-152.

10. Sydney GB, Santos IM, Batista A, Kowalczyk A, Deonizio MDA. The implementation of rotary systems in endodontics. *Rev Odontol Bras Central*. 2014;23(65):113-20.

11. Instituto Brasileiro de Geografia e Estatística.
<https://www.ibge.gov.br/cidades-e-estados/mg.html> Accessed March 10, 2020

12. Conselho Federal de Odontologia
<http://cfo.org.br/website/estatisticas/quantidade-geral-de-entidades-e-profissionais-ativos/>
Accessed March 10, 2020

13. Lopes HP, Siqueira Jr JF. Endodontia: biologia e técnica. 4ª Ed. Elsevier; 2015.
14. Feix LM, Boijink D, Ferreira R, Wagner MH, Barletta FB. Operating microscope in endodontics: visual magnification and luminosity. Rev Sul-Bras Odontol. 2010 Sep;7(3):340-8.
15. Giusti EC, Fernandes KP, Marques JL. Electronic measure and direct digital radiography for the determination of the root canal longitudinal length: analysis in vivo. RGO. 2007 Jul;55(3):239-46.
16. Ebrahim AK, Wadachi R, Suda H. In vitro evaluation of the accuracy of five different electronic apex locators for determining the working length of endodontically retreated teeth. Aust Endod J. 2007;33(1):7-12.
17. Guimarães BM, Marciano MA, Silva PAM, Alcalde MP, Bramante CM, Duarte MAH. The use of apex locator in endodontics: a literature review. Rev Odontol Bras Central. 2014;23(64):2-7.
18. Ramos CAS, Bramante CM. Odontometria, fundamentos e técnicas. São Paulo: Livraria Santos Editora; 2005. 130 p.
19. Renner D, Grazziotin-Soares R, Gavini G, Barletta FB. Influence of pulp condition on the accuracy of an electronic foramen locator in posterior teeth: an in vivo study. Braz Oral Res. 2012 Apr;26(2):106-11.
20. Ryamundo A, Portela CP, Leonardi DP, Baratto Filho F. Análise radiográfica do preenchimento de canais laterais por quatro diferentes técnicas de obturação. Revista Sul-Brasileira de Odontologia. 2005;2(2):22-7.
21. Gil AC, Nakamura VC, Lopes RP, de Mello Lemos E, Calil E, Amaral KF. Revisão contemporânea da obturação termoplastificada, valendo-se da técnica de compactação termomecânica. Revista Saúde. 2009 Jun;3(3):20-9.

22. Bueno AP, Camacho JCI, Vernimmen FS, de Los Reyes Bueno JC. Estudio comparativo de filtración apical entre la técnica de compactación lateral enfrió y técnica de obturación com System B®. *Revista Odontológica Mexicana*. 2005;9(2):65-72.

23. Ferreira MM, Sanches F, Rodrigues B, Gonçalves D, Dias JPM. Estudo comparativo da infiltração apical de canais radiculares obturados por duas técnicas diferentes. *Revista Portuguesa Estomatologia Cirurgia Maxilofacial*. 2006;47:133-8.

24. Martins SC, Mello J, Martins CC, Maurício A, Ginjeira A. Comparação da obturação endodôntico pelas técnicas de condensação lateral, híbrida de Tagger e Termafil: estudo piloto com Micro-tomografia computadorizada. *Revista Portuguesa de Estomatologia, Medicina Dentária e Cirurgia Maxilofacial*. 2011 Apr;52(2):59-69.

25. Roldi A, Intra JB, Barroso JM, Intra TJ, Martins LO. Avaliação da variação da temperatura na superfície radicular externa durante a obturação pela técnica de McSpadden. *Rev Odontol Bras Central*. 2010 Mar;19(48).

26. Tavares WL, Lopes RC, Borges DC, Henriques HL, Ribeiro Sobrinho AP. Choice of the Tagger's hybrid technique for the filling of root canals in a post-graduate clinic in endodontics. *Arquivos em Odontologia*. 2012 Mar; 48(1):26-31.

27. Plotino G, Grande NM, Mercade M. Photodynamic therapy in endodontics. *Int Endod J*. 2019 Jun;52(6):760-74.

28. Chrepa V, Kotsakis GA, Pagonis TC, Hargreaves KM. The effect of photodynamic therapy in root canal disinfection: a systematic review. *J Endod*. 2014 Jul;40(7):891-8.

29. Amaral RR, Cohen S, Ferreira MVL, Soares BM, de Souza Côrtes MI. Antimicrobial Photodynamic Therapy associated with long term success in endodontic treatment with separated instruments: A case report. *Photodiagn Photodyn*. 2019 Jun;26:15-8.

30. Soukos NS, Chen PS, Morris JT, Ruggiero K, Abernethy AD, Som S, Foschi F, Doucette S, Bammann LL, Fontana CR, Doukas AG. Photodynamic therapy for endodontic disinfection. *J Endod*. 2006 Oct;32(10):979-84. Epub 2006 Jul 13.

31. van der Sluis, versluis M, Wu MK, Wesselink PR. Passive ultrasonic irrigation of the root canal. *Int Endod J*. 2007 Jun;40(6):415-26. Epub 2007 Apr 17.

32. Raisi HL, 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 Jul;52(7):1077-85. Epub 2019 Mar 9.

33. Conselho Federal de Odontologia
<http://cfo.org.br/website/cfo-reforca-necessidade-do-ministerio-da-educacao-suspender-autorizacoes-para-abertura-de-novos-cursos-de-odontologia/> Accessed March 10, 2020

34. Morita MC, Scavuzzi AIF, Carcereri DL, Fontanela VRC. Documento orientador da ABENO para qualidade dos cursos de graduação em Odontologia. *Rev Abeno*. 18 (supl.2):1-38, 2018.

35. De Moor R, Hulsmann M, Kirkevang L-L, Tanalp J, Whitworth J. Undergraduate Curriculum Guidelines for Endodontology. *Int Endod J*. 2013 Oct;46(10): 1105–1114.

Tables

Table 1: Questionnaire sent to the 54 institutions registered in Minas Gerais

Questionnaire
1- When is the discipline of endodontics taught to undergraduate students?
2- Do the undergraduate students use the Pulp Tester device during pulp diagnosis? Always () Often () Sometimes () Never () In case of a negative response, justify.
3- Do the undergraduate students use digital radiography during endodontic treatment? Always () Often () Sometimes () Never () In case of a negative response, justify.
4- Do the undergraduate students use an apex locator to determine the working length? Always () Often () Sometimes () Never () In case of a negative response, justify.
5- Do the undergraduate students perform root canal instrumentation with a NiTi rotary system? Always () Often () Sometimes () Never () In case of a negative response, justify.
6- Do the undergraduate students perform root canal instrumentation with a NiTi reciprocating system? Always () Often () Sometimes () Never () In case of a negative response, justify.
7- Do the undergraduate students perform root canal instrumentation with the Adaptive Motion hybrid system? Always () Often () Sometimes () Never () In case of a negative response, justify.
8- Is root canal disinfection supplemented by the use of Photodynamic Therapy (PDT)?

<p>Always () Often () Sometimes () Never ()</p> <p>In case of a negative response, justify.</p>
<p>9- Is root canal disinfection supplemented by the use of passive ultrasonic irrigation? Always () Often () Sometimes () Never ()</p> <p>In case of a negative response, justify.</p>
<p>10- Is the ultrasonic device used during the following stages of endodontic treatment?</p> <p>10.1 Access cavity preparation: Always () Often () Sometimes () Never ()</p> <p>10.2 Locate calcified canals: Always () Often () Sometimes () Never ()</p> <p>10.3 Retrieval of broken instruments: Always () Often () Sometimes () Never ()</p> <p>10.4 Endodontic retreatment: Always () Often () Sometimes () Never ()</p> <p>In case of a negative response, justify.</p>
<p>11- Is the operating microscope used during the following stages of endodontic treatment?</p> <p>11.1 Access cavity preparation: Always () Often () Sometimes () Never ()</p> <p>11.2 Locate calcified canals: Always () Often () Sometimes () Never ()</p> <p>11.3 Retrieval of broken instrument: Always () Often () Sometimes () Never ()</p> <p>11.4. Endodontic retreatment: Always () Often () Sometimes () Never ()</p> <p>In case of a negative response, justify.</p>
<p>12. Is the root canal filling performed with a thermoplastic obturation system?</p> <p>Always () Often () Sometimes () Never ()</p> <p>In case of a negative response, justify.</p>

Table 2: Use of microscopes in the surveyed institutions

	Access cavity	Locate calcified	Retrieval of broken	Endodontic
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	preparation	root canals	instruments	retreatment
Always	0	0	0	0
Often	1	2	1	0
Sometimes	4	3	2	4
Never	14	14	16	15

Table 3: Use of ultrasonic endodontic instruments in the surveyed institutions

	Access cavity preparation	Location of calcified root canals	Retrieval of broken instruments	Endodontic retreatment
Always	1	1	3	2
Often	0	2	1	0
Sometimes	6	6	4	2
Never	12	10	12	15

	Digital Radiography	Electronic Apex Locator	Thermoplastic Obturation System	PDT	PUI
Always	3	0	0	0	1
Often	2	4	0	0	0
Sometimes	5	11	4	0	3
Never	9	4	15	19	15

Table 4: Use of contemporary technologies in the surveyed institutions

Figure legends:

Figure 1: The semester during which endodontics is taught in the undergraduate curriculum

Figure 2: Frequency of usage of the pulp sensitivity test

Figure 3: Frequency of usage of the *NiTi* file system

Beginning of Undergraduate Endodontic Training

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