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Teaching models of Endodontics in undergraduate courses in Dentistry in the State of Amazonas

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Abstract This study analyzed information regarding the teaching of Endodontics in undergraduate courses in Dentistry in the State of Amazonas. A quantitative, observational cross-sectional study of the survey type was designed, answered by the professors responsible for the area, which mapped the teaching model in courses with concept 3 or higher in Enade 2019 (n=3). The response rate was 100%. On average, the number of students per class was 40 individuals, two courses reported that endodontics comprises integrated disciplines with the supervision of 2 to 3 specialist professors. There was consensus on the syllabus content, namely: internal anatomy; stainless steel and NiTi endodontic instruments; filling materials; intracanal medication and irrigating solutions; pulpal and periapical pathology; philosophy of endodontic treatment and endodontic emergencies. Regarding protocols, manual odontometry is performed in all courses; the foraminal patency maneuver is taught in all courses, being performed in the treatment of vital and necrotic teeth in two courses. The apical limit varied between 0.5 and 1mm for teeth with necrosis or pulpal vitality, respectively. The use of manual, rotary and reciprocating NiTi instrumentation systems are taught in all three courses, but the manual is predominant. There was consensus on the use of 2% sodium hypochlorite as an irrigating solution and on the choice of calcium hydroxide as the basis for intracanal medication. It is concluded that the courses have convergence of the Endodontics teaching model, mainly in the foundations of the specialty, which are the integration with other disciplines, the workload, the treatment goals, the syllabus and the presentation of new technologies.
Descriptors: Education, Dental. Endodontics. Curriculum.

Modelos de enseñanza de Endodoncia en cursos de graduación en Odontología en el Estado de Amazonas

Resumen Este estudio analizó informaciones sobre la enseñanza de Endodoncia en cursos de graduación en Odontología en el Estado de Amazonas. Se diseñó un estudio transversal observacional cuantitativo del tipo encuesta, respondida por los profesores responsables del área, que mapeó el modelo de enseñanza en cursos con concepto 3 o superior en Enade 2019 (n=3). La tasa de respuesta fue del 100%. En promedio, el número de alumnos por clase fue de 40 individuos, dos cursos informaron que la endodoncia comprende disciplinas integradas con la supervisión de 2 a 3 profesores especialistas. Hubo consenso sobre el contenido del plan de estudios, a saber: anatomía interna; instrumentos de endodoncia de acero inoxidable y NiTi; materiales de relleno; medicación intracanal y soluciones de irrigación; patología pulpar y periapical; filosofía del tratamiento endodóntico y emergencias endodónticas. En cuanto a los protocolos, en todos los cursos se realiza odontometría manual; la maniobra de permeabilidad foraminal se enseña en todos los cursos, realizándose en el tratamiento de dientes vitales y necróticos en dos cursos. El límite apical varió entre 0,5 y 1 mm para dientes con necrosis o vitalidad pulpar, respectivamente. En los tres cursos se enseña el uso de sistemas de instrumentación manuales, rotatorios y alternativos de NiTi, pero predomina el manual. Hubo consenso en el uso de hipoclorito de sodio al 2% como solución de irrigación y en la elección del hidróxido de calcio como base para la medicación intracanal. Se concluye que los cursos tienen convergencia del modelo de enseñanza de Endodoncia, principalmente en los fundamentos de la especialidad, que son la integración con otras disciplinas, la carga

horaria, los objetivos del tratamiento, el temario y la presentación de nuevas tecnologías.
Descriptores: Educación en Odontología. Endodoncia. Curriculum.

Modelos de ensino da Endodontia em cursos de graduação em Odontologia do Estado do Amazonas
Resumo Este estudo analisou informações referentes ao ensino de Endodontia nos cursos de graduação em Odontologia do Estado do Amazonas. Foi delineado um estudo quantitativo, observacional de corte transversal do tipo survey, respondido pelos docentes responsáveis pela área, que mapeou o modelo do ensino nos cursos com conceito 3 ou superior no Enade 2019 (n=3). A taxa de resposta foi de 100%. Em média a quantidade de alunos por turma foi de 40 indivíduos, dois cursos relataram que a endodontia compõe disciplinas integradas com a supervisão de 2 a 3 docentes especialistas. Houve consenso quanto ao conteúdo programático, sendo estes: anatomia interna; instrumentos endodônticos de aço inox e NiTi; materiais obturadores; medicação intracanal e soluções irrigantes; patologia pulpar e periapical; filosofia do tratamento endodôntico e emergências endodônticas. Em relação aos protocolos, a odontometria manual é realizada em todos os cursos; a manobra de patência foraminal é ensinada em todos os cursos, sendo realizada no tratamento de dentes vitais e necrosados em dois cursos. O limite apical variou entre 0,5 e 1mm para dentes com necrose ou vitalidade pulpar, respectivamente. A utilização de sistemas de instrumentação de NiTi manuais, rotatórios e reciprocantes são ensinados nos três cursos, porém o manual é predominante. Houve consenso na utilização do hipoclorito de sódio a 2% como solução irrigante e da escolha do hidróxido de cálcio como base da medicação intracanal. Conclui-se que os cursos possuem convergência do modelo de ensino da Endodontia, principalmente nos alicerces da especialidade que são a integração com outras disciplinas, a carga horária, as metas de tratamento, o conteúdo programático e a apresentação das novas tecnologias.
Descritores: Educação em Odontologia. Endodontia. Currículo.

INTRODUCTION

In Brazil, dental schools follow the national curriculum guidelines (NCGs) from the Ministry of Education to structure their programs. The NCGs value a model based on generalist training, comprehensive health care according to the regional system, reference and counter-reference system, with interprofessional teamwork, ordered by the Unified Health System (SUS)[1].

Based on the NCGs, institutions in the country have autonomy to develop their programs. The contents of Endodontics are usually presented in the professionalizing stage of the program, first as pre-clinical courses and later at outpatient clinics. In Brazil, this theme is incipiently explored. A study surveyed 246 dental schools registered at the Federal Council (e-MEC) and the results showed that there is no detailed information that can be summarized to describe the pre-clinical teaching model of Endodontics in Brazilian institutions[2].

Dental students tend to consider the practice of endodontics difficult, especially in complex clinical cases, which makes it challenging for professors to build students' knowledge on endodontics[3]. Over the past decades, pre-clinical and clinical endodontic education in European countries has developed positively, largely because institutions follow the recommendations of the Council of European Dentistry and the European Society of Endodontology[4].

The recommendations of the European Society are based on the evolution of endodontic education due to improvements in the teacher/student ratio, qualification and advanced endodontic training of teaching staff and more clinical hours for endodontic procedures[4]. However, in a study that investigated the pre-clinical endodontic education in German dental schools, considerable differences between some institutions were observed due to the variety of course designs, qualification of teaching staff, and different teaching contents[5].

To understand clinical endodontic education in Brazil, Otto, Grock and Montagner (2019)[6] analyzed the teaching content in endodontics at 452 dental courses by consulting data of the program on the websites of the institutions. The results showed that there is little information available, making it impossible to analyze the course design adopted in the country.

In Brazil, little is discussed about teaching contents adopted in higher education. Therefore, the aim of the present study was to identify and analyze information related to undergraduate endodontic education in dental schools in the state of Amazonas.

METHODS

This electronic research was designed as a quantitative, prospective observational, cross-sectional survey that used an electronic questionnaire to analyze undergraduate endodontic education in dental schools in the state of Amazonas. The research was approved by the Research Ethics Committee (CEP) of Federal University of Amazonas (UFAM) under protocol nº 4,854,666 (CAEE: 48120521.0.0000.5020).

The sample consisted of undergraduate dental programs in the state of Amazonas that obtained a score equal to or higher than 3 in the 2019 edition of Enade (National Student Performance Exam). To contact the universities, the email addresses were obtained by consulting the open-access public website of the Ministry of Education using the e-MEC system of INEP (http://emec.mec.gov.br/emec/nova#avancada). Emails were sent to the coordinators so that they could indicate which professor at the institution, responsible for the area of Endodontics, would answer to the questionnaire.

Shared email lists were not used to protect the identity of participants. The messages were sent individually to each dental school using the institutional e-mail of the research coordinator.

The invitation to participate in the research was included in the text of the e-mail followed by the guidelines about the process. The questions in the research form were not mandatory, and the full questionnaire could be viewed before submission. Participants could withdraw from participating in the research at any time. By clicking on the electronic survey link, the participant had access to the Google form and the electronic informed consent. The entire electronic questionnaire process was anonymous to protect the identification of the participant and of the institution.

The data available for consultation on the E-MEC website were as follows: name of the institution, code of the school, legal nature, name of the coordinator, website, institutional email, and the Enade 2019 results.

The electronic questionnaire consisted of 21 questions on the following domains: general questions about the description of pre-clinical and clinical disciplines of Endodontic; workload; teaching contents; teacher-student ratio; teacher qualifications; teaching methodology; type of endodontic philosophy practiced; use of microscopes, and extracurricular activities.

Institutional data and participants' responses were tabulated in Excel spreadsheets (Microsoft Excel, Microsoft Inc., Redmond, WA, USA). Data from the answers to the questionnaires were analyzed using descriptive statistics and expressed as absolute or relative frequencies.

RESULTS

The state of Amazonas had, at the time of the research, 9 authorized graduation courses in Dentistry, which are all located in the capital city Manaus. Of the 9 schools, 2 are from public institutions and the other 7 from private institutions. Dental schools with a grade of 3 or higher in the 2019 edition of Enade were invited to participate in this study, totaling 3 institutions. The response rate to the questionnaire was 100%. The absolute and relative results can be seen in Table 1.

Survey participants reported that there were 40 students on average in each classroom. Endodontics is inserted in the graduation in an integrated way with other areas of knowledge in two courses, both in pre-clinical disciplines and in integrated clinics.

The workload dedicated to pre-clinical and clinical Endodontics throughout the program was greater than 60 hours and 200 hours, respectively. In total, the professors in charge of endodontics have PhD degrees and 2 (34%) to 3 (66%) professors taught endodontics during practical classes.

Table 1. Absolute and relative results of answers of participating institutions.

Questions	(n) Answers	(%) Frequency*
Do you wish to participate in the research? (IC)		
Yes	3	100%
No	-	-
How many students, on average, are there in the classrooms at your school?		
40 students	2	66%
Is endodontics taught as an independent course?		
No, endodontics is integrated with other courses.	2	66%
Yes, endodontics is taught independently.	1	34%
Which are the courses that are integrated with the teaching content in endodontics?		
Integrated pre-clinical and clinical courses (with other courses/disciplines)	2	66%
Isolated endodontic courses	1	34%
Which is the average workload of endodontic education in comparison with the other courses at		
Pre-clinical > 60h	3	100%
Pre-clinical < 60h	-	-
Clinical > 200h	3	100%
Clinical < 200h	-	-
Which is the highest academic qualification of professors teaching endodontics?		
PhD degree	3	100%
Master's degree	-	-
How many professors, on average, teach endodontics at the same time?		
3 professors	1	34%
2 professors	2	66%
In which semester do students begin laboratory studies in Endodontology?		
6th semester	1	34%
5th semester	2	66%
In which semester do students begin endodontic treatments on patients?		
7th semester	1	34%
6th semester	2	66%
Check below the topics in endodontics that are addressed at undergraduate degree:		
Internal anatomy of teech	3	100%
Stainless steel manual endodontic instruments	3	100%
NiTi endodontic instruments	3	100%
Sealing materials	3	100%
Intracanal medication	3	100%
Irrigating solutions	3	100%
Mechanical and chemical root canal preparation with stainless steel manual instruments	3	100%
Mechanical and chemical root canal preparation with NiTi manual instruments	2	66%
Mechanical and chemical root canal preparation with NiTi rotary instruments	2	66%
Mechanical and chemical root canal preparation with NiTi reciprocating instruments	1	34%
Pulp histology	2	66%
Pulp and periapical pathology	3	100%
Philosophy of endodontic treatment	3	100%
Endodontic retreatment	2	66%
Endodontic emergencies	3	100%
Restoration of endodontically treated teeth	2	66%
Whitening of endodontically treated teeth	2	66%
Dental trauma	2	66%
Endodontic emergencies	3	100%
Endodontic surgery	1	34%
Temporary sealers	2	66%
Endodontic treatment of primary teeth	1	34%
Regenerative endodontics	0	0%
How do students perform clinical practice?		
Extracted human teeth	3	100%
During clinical classes, do students have treatment goals? If yes, how many teeth in total throughout		
Yes, at least 1 complete treatment	1	34%
Yes, on average 5 complete treatments	2	66%

continues

		continuation
What method is used for determining the working length in undergraduate clinics?		
Manual measurement	-	-
Electronic apex locator	-	-
The two options, but the manual method is more frequent	3	100%
Is apical patency taught?		
Yes, only in cases of necrotic teeth	1	34%
Yes, in cases of vital and necrotic teeth	2	66%
What is the apical stop for cases of vital teeth?		
0.5mm short of the apex	2	66%
1.0mm short of the apex	1	34%
What is the apical stop for cases of pulp necrosis?		
0.5mm short of the apex	2	66%
1.0mm short of the apex	1	34%
Is any preparation method taught using NiTi systems? Check up to two most common systems		
Yes, only manual NiTi systems	2	66%
Yes, manual, rotary and reciprocating NiTi systems	1	34%
What is the irrigating solution of choice used in the course? Check the most common solution used		
2% sodium hypochlorite (NaOCl) or >	3	100%
Which intracanal medication of choice is used after total root-canal debridement?		
Calcium hydroxide + vehicle (aqueous, viscous, oily solution or + PMCP)	3	100%
Are microscopes used during the course?		
Yes, but rarely and only the professor uses it	2	66%
No	1	34%
Are there any outreach programs or Endodontic groups during undergraduate studies for students		
Yes	2	66%
No	1	34%

* Rounded values

In two of the institutions, students' first classes in laboratory and clinical studies in Endodontics are in the 5th and 6th semesters of the program, respectively. In the third institution, this contact occurs in the 6th and 7th semesters, respectively. In two institutions, activities or university outreach projects in Endodontics are offered to students who wish to deepen their knowledge in the field.

There was a consensus among the dental schools regarding the teaching contents during undergraduate studies: internal anatomy of teeth; stainless-steel manual endodontic instruments; NiTi endodontic instruments; sealing materials; intracanal medication; irrigating solutions; mechanical and chemical root canal preparation with manual instruments; pulp and periapical pathology; philosophy of endodontic treatment (vital and necrotic teeth); and endodontic emergencies. The following topics are covered by only one school, such as endodontic treatment of primary teeth, endodontic surgery, and chemical-mechanical root canal preparation with reciprocating instruments. Regenerative endodontics is not covered at any dental schools.

All dental schools reported that students must meet goals during practical classes. A requirement of 1 to 5 complete Endodontic treatments was observed. In all courses, students perform laboratory training on extracted human teeth. At all dental schools, students perform laboratory training on extracted human teeth.

As for the method used to determine the working length, both manual measurement and electronic apex locators are reported. However, the manual method is used more frequently. The apical patency is used in in two of the three schools for cases of vital and necrotic teeth and in one of them only for necrotic teeth. To establish the apical stop in vital and necrotic teeth, it was observed that two institutions recommend 0.5 mm below the apex, while the third institution recommends 1.0 mm below the apex.

As for the use of NiTi instruments during mechanical and chemical root canal preparation, two courses use manual systems and rotary and reciprocating systems are used in special cases in academic outreach programs. Regarding the use magnification systems, two courses have an operating microscope, but it is rarely used and only used by the professors.

All dental schools use irrigating solutions and intracanal medications in endodontic treatments. A 2% NaOCl solution, or at a higher concentration, is used in all treatments and medication based on calcium hydroxide associated with a vehicle

(aqueous, viscous, oily) with or without the addition of camphorated paramonochlorophenol is used after total root-canal debridement.

DISCUSSION

The present study investigated undergraduate endodontic education in dental schools in the State of Amazonas. Of the nine dental schools in the state and registered in the e-MEC, those with a score greater than or equal to 3 in Enade 2019 were selected, totaling three courses. These courses have shown satisfactory performance in the last three editions of Enade, as the scores have been 3-5 since 2010, which provides credibility and relevance to the data collected.

Although undergraduate education follows national curriculum guidelines in Brazil (NCG)[1], institutions have autonomy to develop their teaching contents because the guidelines do not determine which teaching contents must be in the program, nor the workload or any other specifications in each field of knowledge. Thus, heterogeneous approaches in teaching preclinical Endodontics have already been reported in Brazil, which raised questions on the importance of a more homogeneous educational model with higher levels of requirements among programs[2].

The discussion on the importance of having a national or regional guidelines to standardize endodontic education in undergraduate programs is not a recent claim, as it has been raised since 1990 by professors in the field. At the time, studies on dental schools in the United Kingdom and the United States of America have reported concern about the variety of the course designs, low qualification of teaching assistants, and low workload dedicated to Endodontics among the schools studied[7].

One of the pillars of quality in education is related to the qualification of teachers and the teacher-student ratio, which result in better teaching management skills and identification of limitations and learning gaps[7]. In this context, the three dental schools showed good qualifications and teacher-student ratio in practical classes. The quality of the teacher-student ratio in Dental education is considered an essential aspect for a successful teaching-learning process[8].

As for integration, Endodontics is integrated with other courses in two dental schools. In a study published in Brazil in 2008, the importance of integrated courses in undergraduate education had already been addressed. The authors observed that when endodontic education is integrated with clinical practice it can provide a comprehensive view of the patient's health status, which is important for the dentist in training, and promote interdisciplinarity and transdisciplinary[9].

Likewise, international guidelines, such as those of the European Society of Endodontology, recommend that the general treatment of patients can be best achieved by the integration of endodontic knowledge with aspects of cariology, conservative dentistry, restorative dentistry, surgical dentistry, pediatric dentistry, traumatology, and periodontology[10]. On the other hand, despite significant workload, an integrated curriculum model can mean that students must divide their time of practice between different clinical courses. Thus, students and teachers may perceive that gaining skills in some fields of knowledge is difficult[11].

Mastering the techniques of dental procedures requires a good understanding of the underlying cognitive, sensory, and neuromuscular processes[12]. The workload and training time offered by the courses directly impact the cognitive and fine motor skills of students. Thus, coordinators must be aware of this issue and offer alternatives to optimize learning through outreach programs, such as academic groups, that are widely used in Medical education to complement content or reinforce protocol practices in undergraduate studies[13].

Two of the dental schools in this research, which have an integrated curriculum, offer outreach programs in Endodontics to further student training. Academic groups, organized and monitored by the institution, can be a way of disseminating advancements in knowledge and they should be stimulated by institutions, as these activities are integral parts of modern and inclusive teaching-learning processes[14]. An outreach project, which was recently reported, addressed the impact of Podcasts in the routine of Endodontic studies. Preliminary data showed that the digital tool produced by the Endodontic group, which addressed all topics taught in undergraduate studies, was well accepted by students and enhanced endodontic teaching[15].

Endodontic education is similar in the three dental schools assessed. However, pulp regeneration or pulp revascularization are not addressed by any of the dental schools. A recent systematic review that assessed clinical trials for pulp regeneration showed satisfactory and promising results in comparison with conventional treatments in necrotic

teeth with incomplete root formation. Thus, pulp revascularization is a treatment option for general practitioners that should be available in undergraduate education[16].

Institutions also use endodontic technologies in an incipient way. The three dental schools use manual measurement of the working length and electronic apex locators, but the former is more frequent. Using an electronic apex locator minimizes possible problems during endodontic treatment and ensures an effective treatment procedure. Therefore, there is no reason why it is not used in undergraduate education. In a study conducted in the state of Minas Gerais, despite the several technologies available to facilitate endodontic treatment, the authors reported that most dental schools did not address these innovations and the use of electronic apex locators was rare[17]. On the other hand, in dental schools in Spain, 95% of institutions use electronic apex locators, which shows that this technology is part of the undergraduate curriculum[18], data similar to that found in dental schools in the United Kingdom[4].

Another point of divergence between the dental schools was apical patency and determination of the working length, but the characteristics reported are within the acceptable scientific limits[19].

All institutions teach chemical and mechanical root canal preparation methods using NiTi systems, although manual instruments are predominant. The use of rotary or reciprocating instruments by undergraduate students still differs in the literature. Satisfactory results have been previously reported in Brazil[20]. In France, there is a national consensus on the use of rotary NiTi systems by undergraduate students, who have theoretical and practical classes on the subject[21]. On the other hand, manual stainless-steel instruments have proven to be safer than rotary instruments for inexperienced students[22].

Studies carried out in Spain and England have observed that universities have included advanced technologies in endodontic treatments, such as electronic apex locators, rotary instruments and bioceramic sealers. However, the use of modern obturation techniques, microscopes and ultrasonic instruments have not yet been fully adopted[18,23]. In turn, it has already been argued that undergraduate students, who carefully perform root canal instrumentation, can successfully perform root canal shaping with rotary instruments and achieve better root canal shaping than with manual instruments[24]. Thus, the use of rotary instruments by students seems acceptable and they can be included in the curriculum of undergraduate dental courses[25].

It is common for students to perform endodontic training on extracted human teeth or on simulated root canal models[26] with the goal of performing 10 complete endodontic treatments[5]. The use of human teeth is complex from an ethical-legal point of view and should be controlled by a biobank or a human tooth bank, thus offering dental elements for teaching and research in an ethical and biologically safe way. However, it is still common to collect teeth from public services or private clinics and, in some cases, teeth are acquired through unethical means[27].

All dental schools use NaOCl at a concentration of 2% or higher as an irrigating solution and calcium hydroxide as intracanal medication. A study also reported that UK institutions use NaOCl alone, or in association with EDTA, or a saline solution for irrigation and calcium hydroxide as intracanal medication[4].

As observed by Kappler et al. (2019)[2], there are differences in the structure of endodontic teaching among the institutions in this research, corroborating the thought that each dental school is free to decide how the teaching-learning process will be conducted.

The main limitation of the study was the small number of eligible institutions, representing one third of the Dentistry courses in the State of Amazonas. The other dental schools have scores 1, 2, or have not yet been evaluated, which reveals the complexity of the topic when approaching the quality of higher education in Brazil. Although dental schools are evaluated by the government through the National Higher Education Assessment System (SINAES), schools do not seem to improve and students are subject to deficient education, which indirectly contributes to the fragmentation of the profession[28]. Thus, it is suggested that the present methodology could be replicated in other Brazilian states and regions. In this way, a broader panorama of the teaching of Endodontics in Brazil can be envisioned.

Considering that dental caries has a high prevalence around the world[29], especially in low socioeconomic groups[30], and that it can cause a pathologic process if untreated [31], those in charge of Dental Schools must seek training for general practitioners to prepare them to diagnose and treat dental caries and perform endodontic interventions of low complexity in all teeth. By doing so, Endodontics will be forced to adopt technological advances in undergraduate education. For

the meantime, these technologies could be gradually included in endodontic education to demystify the field and strengthen scientific evidence.

CONCLUSION

It may be concluded that Dentistry courses in the state of Amazonas, with grade 3 or higher in Enade, have similar, particularly regarding integration with other courses, workload, treatment goals, teaching contents, philosophy of endodontics, and use of new technologies.

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