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A multicentric survey to evaluate preclinical education in Endodontology in German-speaking countries

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Abstract

Aim: To evaluate preclinical education in Endodontology at Austrian, German and Swiss dental schools using an online survey.

Methodology: An online survey divided into nine categories was sent using *SurveyMonkey* software to 37 dental schools, before the spread of the COVID-19 pandemic. The questionnaire included 50 questions to evaluate preclinical endodontic education, such as faculty-to-student ratios, topics taught and materials used, in preclinical phantom head courses. Seven and 14 days after the first e-mail contact, dental schools received a reminder e-mail. After four and six weeks, the dental schools were contacted by telephone and asked to participate in the online survey. The processing time was eight weeks in total.

Results: The response rate was 89%. Preclinical endodontic education at the participating dental schools differs considerably. Theory classes ranged from 1 to 70 h (15 h mean), and practical classes ranged from 3 to 78 h (39 h mean). The faculty-to-student ratio varied between 1:4 and 1:38 (1:15 mean). Forty-five per cent of the dental schools had a specialist in endodontics teaching theory. Several dental microscopes were available for preclinical teaching purposes at 82% of the dental schools. The majority (82%) taught root canal preparation with rotary or reciprocating NiTi instruments. Overall, 85% of the dental schools taught lateral compaction, amongst other methods, for canal filling.

Conclusion: A substantial divergence amongst the dental schools regarding the time dedicated to theory and practical instruction in Endodontology was reported. However, convergence in the use of root canal treatment techniques and materials was reported.

KEYWORDS

dental school, endodontic curriculum, endodontic education, endodontics, online survey, preclinical

INTRODUCTION

On a national and international level, various curricula in preclinical and clinical endodontic education have been evaluated and published (Al Raisi et al., 2019; Cruz et al., 2000; Narayanaraopeta & Alshwaimi, 2015; Petersson et al., 2002; Qualtrough et al., 1999; Sonntag et al., 2008). Al Raisi et al. (2019) conducted a survey in the United Kingdom

from November 2017 to January 2018 on basic preclinical and clinical endodontic education at British dental schools and compared the results with an earlier paper-based survey. The study revealed great divergences, especially in the faculty-to-student ratios, time management and teaching methods at British dental schools. Sonntag et al. (2008) evaluated endodontic training in Germany noting that preclinical endodontic training varied considerably amongst German dental schools due to differences in curricular design, staff and course content. Considerable differences exist amongst European countries in terms of curricular structure and content, as well as the extent of practice generally in dental education (Scott, 2003).

The aim of this study is to evaluate the current status of preclinical endodontic education in Austria, Germany and Switzerland. Results were compared with a survey conducted more than a decade ago (Sonntag et al., 2008) and the guidelines of the European Society of Endodontology (ESE) (ESE, 2013).

MATERIALS AND METHODS

After consultation with the ethics committee of the Department of Medicine at the Goethe University in Frankfurt am Main, Germany, it was decided that an ethics committee vote was not required (reference 114/2019).

The conception behind and initial validation of the German Endodontology Questionnaire (GEndoQ) used in this study have been published (Sacha et al., 2020). GEndoQ was drafted before the COVID-19 pandemic so that the necessary switch from conventional teaching (e.g. lectures, seminars) to distance learning (e.g. online lectures) (Meng et al., 2020) is not included in GEndoQ. The questionnaire was implemented using the online survey software *SurveyMonkey*. GEndoQ consists of 50 questions in nine categories. Most questions are multiple-choice questions, with more than one answer possible in some cases. Some questions also offered space for free-text input.

After developing the questionnaire, contact persons had to be identified for the preclinical phantom head course in which endodontics is taught. The respective dental schools were contacted by e-mail or telephone asking for the person in charge. Before the start of the COVID-19 pandemic, invitations to participate in the survey were sent by e-mail to the corresponding people at 30 dental schools in Germany, three dental schools in Switzerland and four dental schools in Austria. The processing time was eight weeks in total, after seven and 14 days the responsible teacher received a reminder via e-mail. After four and six weeks, the dental schools were contacted by telephone and asked to participate in the online survey. Data collection was managed using the *SurveyMonkey* online survey software. An anonymized data summary was generated automatically. Simple descriptive statistics were generated for each survey item.

RESULTS

The survey was answered in full by 33 out of the 37 dental schools (89%). Eight per cent of the dental schools ($n = 3$) only answered up to 22% of the survey questionnaire and could not be included in the evaluation. Only one university (3%) did not take part in the survey.

Students and faculty

On average, 41 students attended the phantom head course in which preclinical endodontics was taught during the 2019/20 winter term (Question 2 = Q2). The percentage of males lay between 14 and 63%, on average 36% (Q3). The faculty-to-student ratio in the phantom head course varied between 1:4 and 1:38; the average was 1:15 (Q4).

At 76% of the dental schools, most of the teaching staff were dentists without specific education in Endodontology, while 58% of the dental schools employed specialist endodontitis to teach the theoretical content (Q5, Q10).

Time management

The total time spent for the endodontology course was reportedly between 15 and 107 h (average 56 h) (Q6). Of these, about 15 h on average were allocated to theory and 39 h to practical endodontic training (Q7, Q8).

Theoretical teaching

Ninety-four per cent of dental schools used combinations of teaching methods and materials, including lectures (multiple answers possible, Q9, Q11, Q13, Figure 1). Most of the dental schools (76%) recommended specific literature to their students (multiple answers possible, Q12). All responding dental schools (91%) offered training on a wide range of topics including RCTs (e.g. shaping, disinfection, obturation), restoration of endodontically treated teeth and endodontic surgery (Q14, Figure 2).

Practical teaching

Various methods were chosen to teach practical endodontics; most dental schools (94%) used demonstrations, followed by hands-on exercises (85%) (multiple answers possible, Q15, Q16, Figure 3). Extracted human teeth were used for

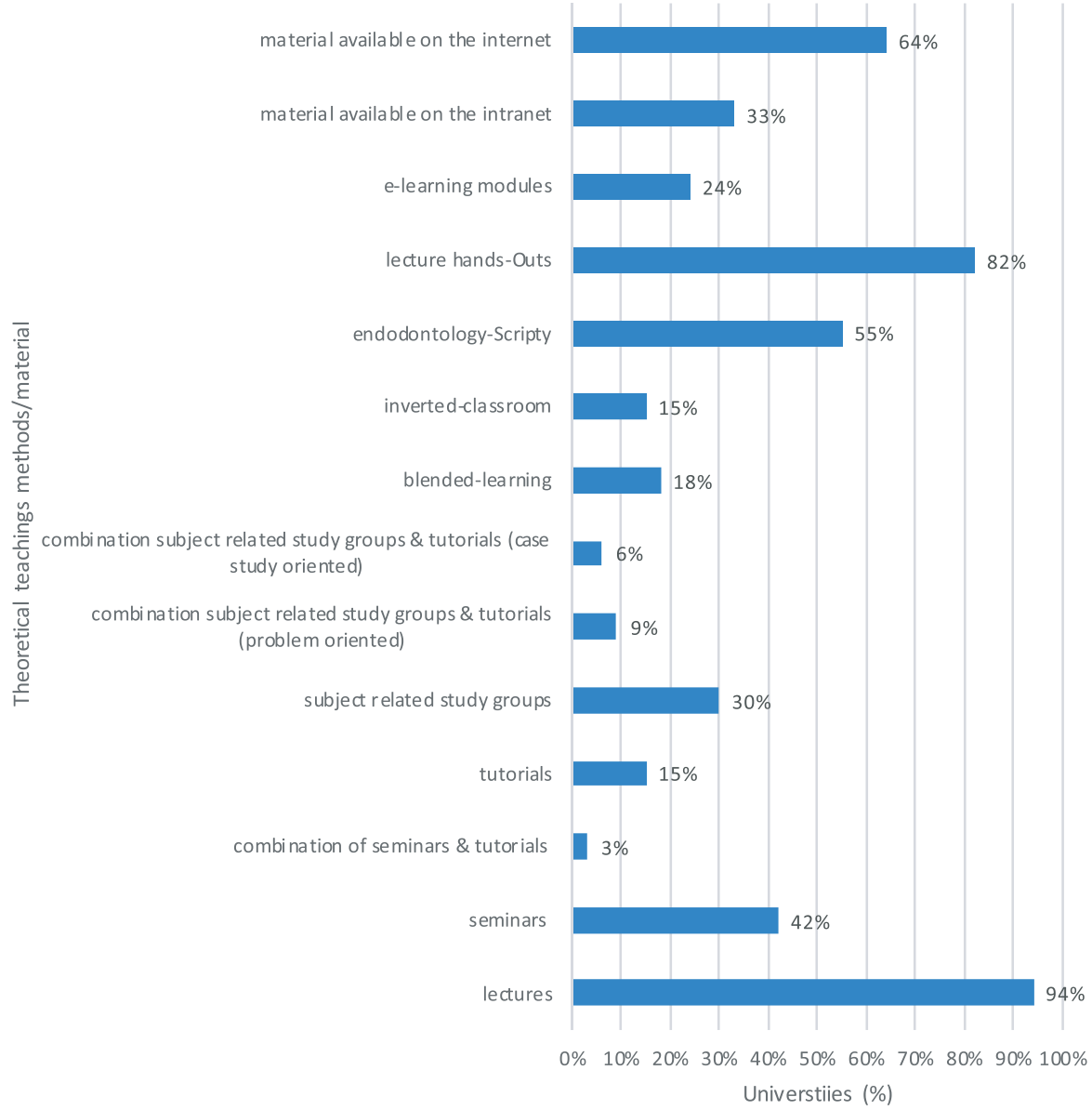

FIGURE 1 Learning-teaching methods and materials used by the responding dental schools to teach theoretical endodontics. The figure also lists which platform the dental schools use to make the material available to their students

practical training at 94% of the dental schools. Fifteen per cent of the dental schools offered patient-specific DVT-based plastic simulation teeth (multiple answers possible, Q17). At 52% of the dental schools, students prepared three to four single-rooted teeth, whereas three to four multirooted teeth were prepared at 15 of 33 dental schools (Q18, Q19). During preclinical training, 19 dental schools (58%) used both electrometric and radiological methods to determine the working length (multiple answers possible, Q20).

When asked about root canal instruments and techniques, 91% of the dental schools taught root canal preparation with manual instruments (multiple answers possible, Q21). Only 61% of the dental schools stated that they used nickel–titanium (NiTi) files manually (Q22). When asked about the file type, 55% of the dental schools used stainless steel K-files, 12% used various NiTi files (K-Flex files, ProTaper files, NiTiFlex files) (multiple answers possible, Q23). Several manual shaping techniques were used (multiple answers possible). Apical–coronal/step-back technique was used most frequently (73%) (multiple answers possible, Q24). Eighty-two per cent reported teaching mechanical root canal preparation with rotary/reciprocal instruments (multiple answers possible, Q25, Q26). The most frequently used root canal irrigation (multiple answers possible) during preclinical training was sodium hypochlorite (NaOCl) (76%), followed by chlorhexidine (CHX) (42%) (multiple answers possible, Q27). Sixteen of 33 of the dental schools (48%) performed root canal irrigation activation. Thirty-six per cent used sonically activated instruments (e.g. EDDY® (VDW), Endoaktivator® (Dentsply)) and 18% used ultrasonically

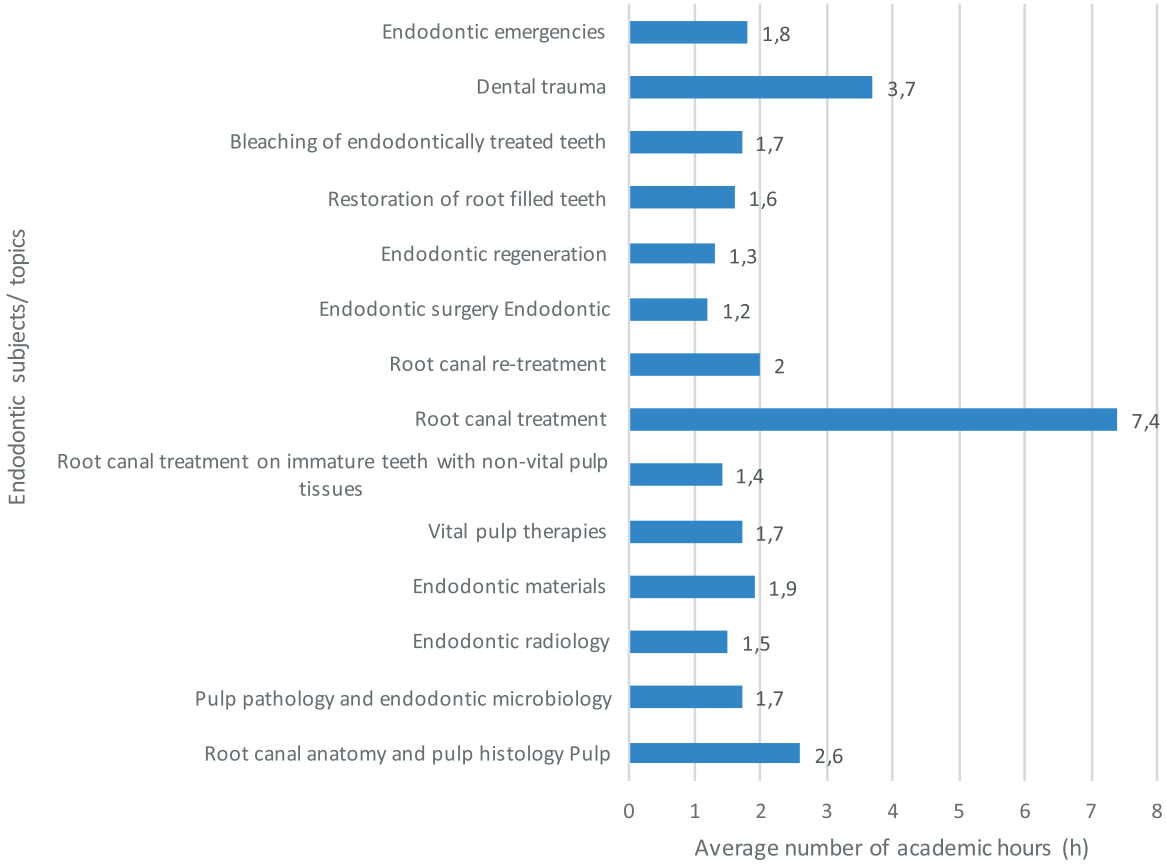

FIGURE 2 Number of hours dedicated to the subjects taught in preclinical endodontic training

activated instruments (e.g. Sonicflex® (KaVo)) (multiple answers possible, Q28).

Forty-eight per cent of the dental schools had one to two dental microscopes available, while 18% did not have any (Q29).

The practical teaching of apexification and the use of suitable materials are not taught in the phantom head course at 52% of the dental schools, while 30% of the dental schools stated that they teach apexification with calcium hydroxide, 27% with mineral trioxide aggregate (MTA) and 18% Biodentine® (Septodont) (multiple answers possible, Q32). Calcium hydroxide as an intervisit canal medication (as a ready-to-use paste) was used by 82% of the dental schools. Six per cent of the dental schools mixed the calcium hydroxide power with chlorhexidine (multiple answers possible, Q33).

The responding dental schools used a variety of methods for root canal filling. All dental schools used root canal filling pastes (sealers) with 91% using epoxy resin sealers such as AH Plus® (Dentsply) (Q34). Lateral compaction was, amongst other methods, used at all dental schools in the phantom head course (85%) (multiple answers possible, Q35). Seventy-six per cent of the dental schools trained their students to place final restorations after completion of the RCT, an adhesive filling, for example (multiple answers possible, Q36).

Thirty-three per cent of the dental schools stated not having a time limit in the phantom head course (Q37). All dental schools had minimum requirements for the number of teeth to be shaped and/or root filled with 32% reporting at least three to four teeth (Q38).

Examinations in theoretical and practical endodontic training

The theoretical content of the courses was assessed by means of structured oral examinations (OSOE = Objective Structured Oral Examination) at 15% of the dental schools and by simple oral examinations at 33% of the dental schools (multiple answers possible, Q39). Thirty per cent of dental schools assessed the practical content in OSCE format (Objective Structured Clinical Examination).

Learning objectives/Goals in endodontology

Thirty-six to 79% of the dental schools strongly agree with the five learning goals listed in Table 1 (Q43).

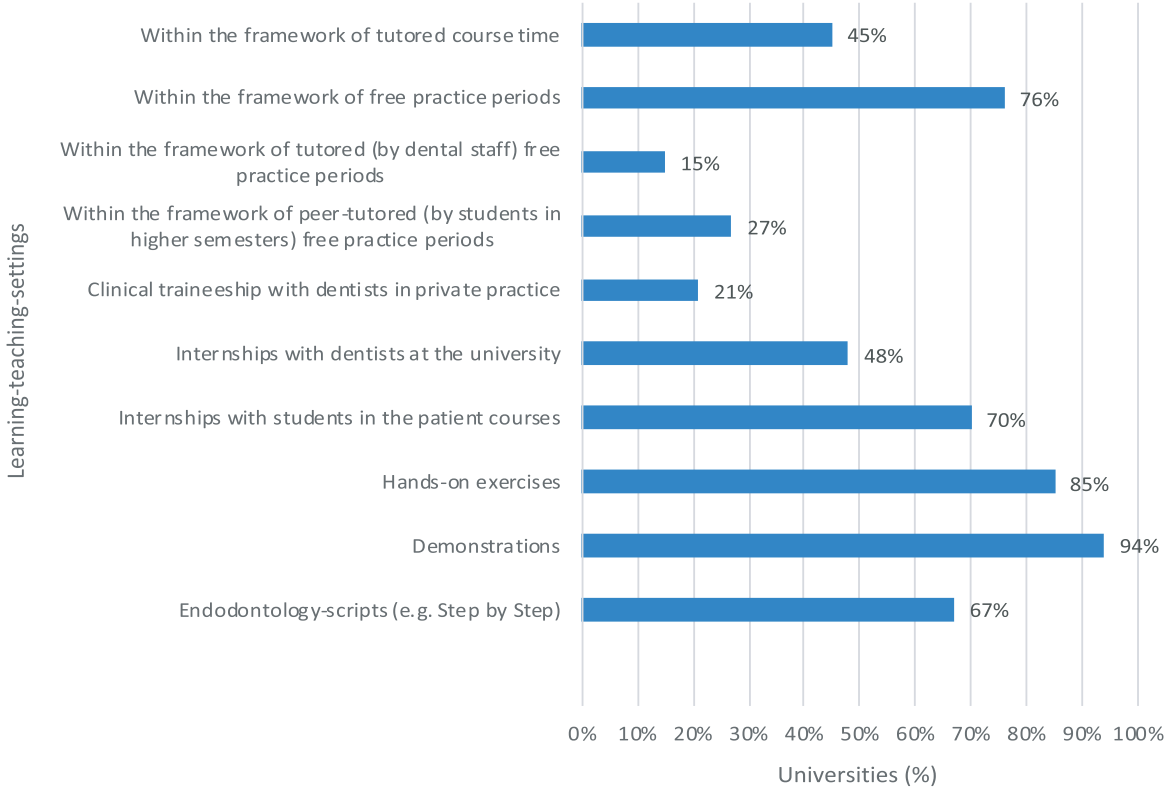

FIGURE 3 Learning-teaching settings used by the responding dental schools to teach practical endodontics

TABLE 1 Learning objectives in the curriculum. The schools indicated the question whether the specific learning objectives apply to their students

The graduates can	Completely disagree	Disagree	Undecided	Agree	Strongly agree	Do not know
Explain the aetiology and pathogenesis of pulmonary and periradicular diseases	1 (3%)	–	1 (3%)	5 (15%)	26 (79%)	–
Diagnose pulp and periapical diseases	1 (3%)	1 (3%)	3 (9%)	7 (21%)	21 (64%)	–
Carry out the prevention of pulp and periradicular diseases	2 (6%)	2 (6%)	2 (6%)	6 (18%)	21 (64%)	–
Plan the endodontic treatment and carry it out	1 (3%)	–	–	6 (18%)	26 (79%)	–
In particular, use primary, but also secondary evidence collected and critically evaluated to make decisions on a medical/dental issue in everyday dental practice	2 (6%)	3 (9%)	7 (21%)	5 (16%)	12 (36%)	4 (12%)

DISCUSSION

With a response rate of 89%, the present survey results provide a reliable picture of preclinical endodontic training in Germany, Austria and Switzerland (Supporting Information). The survey took place in the 2019/2020 winter term before the spread of COVID-19. Since then, digital teaching has taken on a greater significance (Meng et al., 2020; Zawacki-Richter, 2020; Zitzmann et al., 2020), but the content aspects and guidelines are more than five years old (ESE, 2013). To clarify the impact of the COVID-19 pandemic on dental education, further research is needed in the future.

Time management, students and faculty

It is unremarkable that the range of theory and practical instruction varies substantially between the dental schools.

Practical instruction varies between 3 and 78 academic hours (equivalent to 45 min). Generally, it cannot be ruled out that these significant differences in theory and practical classes represent a misinterpretation of the study questions. Sonntag et al. (2008) indicated that the theory class average was 13.3 h and practical training was 45 h. To compare the current results to other publications on western Europe, Al Raisi et al. reported that 87% of the dental schools in the United Kingdom dedicated around 20 h to practical training, which is almost half the time according to the current results of this study showing 38 h. Seventy-eight hours were dedicated to practical training in France, which is twice the time compared with the present results (Arbab-Chirani & Vulcain, 2004). The responding dental schools invest more time (up to 70 h for theoretical training) in endodontic teaching compared with a decade ago in Germany (Sonntag et al., 2008).

In this study, the most favourable faculty-to-student ratio was 1:4, the worst 1:38. The significance of an appropriate faculty-to-student ratio during endodontic education is pointed out by the ESE, but a required minimum is not specified (ESE, 2013). In contrast, the new German licensing regulations for dentists change the faculty-to-student ratio for the phantom head course from the current 1:20 to 1:15 and this would need to be implemented by German dental schools in October 2020 (Federal Law Gazette (Bundesgesetzblatt), 2019). At the moment, 59% of the dental schools surveyed already comply with this regulation, although it should be noted that these are not only German schools. Ultimately, it can be assumed that a low faculty-to-student ratio would create a better learning environment for the individual student and is to be welcomed (Al Raisi et al., 2019).

Theoretical teaching

None of the dental schools indicated that they use modern teaching methods, such as virtual reality (VR), even though studies have shown that the majority of students who have been taught root canal anatomy using the VR method claimed they had gained a better understanding of root canal anatomy (Liebermann & Erdelt, 2020; Reymus et al., 2019a). An online platform for sharing digital files internationally (e.g. VR) could be of benefit for all dental schools (Reymus et al., 2019a).

Practical training

The majority of dental schools (94%) still use extracted human teeth for practical training, which is considered "the gold standard in terms of comparison of the situation on an patient." (Reymus et al., 2019a). Still, there are several disadvantages to this, such as inconsistent availability, time-consuming selection, cross-infection risks and the unfair distribution amongst students (Al-Sudani & Basudan, 2017; Tchorz et al., 2015). To address these disadvantages, 3D-printed artificial teeth based on human teeth can be used and are very well accepted by students (Reymus et al., 2019a; Robberecht et al., 2017). It is even possible to produce 3D-printed artificial teeth for more challenging endodontic procedures, such as sclerosed or more complexly shaped canals (Robberecht et al., 2017). Unfortunately, only 15% of the dental schools offered patient-specific CBCT-based plastic simulation teeth, which may be due to the high costs, although Reymus et al. (2019a) state that "the costs for 3D printing technology [are] constantly declining" and that the initial investment costs should no longer be an obstacle.

In 2008, 63% of the dental schools in Germany taught root canal preparation with rotary nickel–titanium instruments (Sonntag et al., 2008). In a recent study, 82% of the dental schools were using rotary or reciprocating systems. Eighty-two per cent of the responding dental schools offered dental microscopes to their students; in 2008, 63% did not have a dental microscope for preclinical endodontic training (Sonntag et al., 2008). There was a tendency towards the use of more advanced methods and materials such as patient-specific CBCT-based plastic simulation teeth, in comparison with Sonntag et al. (2008).

Learning objectives/Goals in endodontology

GEndoQ determined whether students met specific learning objectives concerning Endodontology (Table 1). Less than half of the dental schools "agreed" (16%) or "strongly agreed" (36%) that their students are able to make evidence-based decisions on a medical/dental issue in everyday dental practice. It is known that the ability to evaluate and apply scientific knowledge is an essential skill for clinical decision-making (Lallier, 2014; Weyant, 2019) and that it is necessary to enable dental students to become evidence-based working professionals (Afrashtehfar et al., 2017; Queen, 2016). As a consequence, evidence-based dentistry (EbD) has been incorporated into national guidelines (Association of Medical Faculties in Germany (Medizinischer Fakultätentag der Bundesrepublik Deutschland e.V.), 2015; Federal Law Gazette (Bundesgesetzblatt), 2019; Zitzmann, 2017). Earlier surveys did not determine aspects of EbD in endodontic education (Sonntag et al., 2008). This means that no change in EbD competences can be described; however, GEndoQ did not focus on the assessment of competences in EbD. Accordingly, in the future the competences in EbD concerning endodontics should be assessed with an appropriate instrument (Imorde et al., 2020).

Clinical decision-making may be influenced by the clinical experience and education of the dentists, as well as by the working environment and health care systems in the countries of interest (Dechouniotis et al., 2010; Lee et al., 2020; McCaul et al., 2001; Parirokh et al., 2015). Therefore, gaps in clinicians' treatment decisions should be identified and addressed in order to reflect these needs in endodontic teaching where appropriate (Conrad et al., 2020; Ree et al., 2003). As already mentioned by Conrad et al. (2020), it is the chief duty of every clinician to provide the best care and treatment to patients according to their preferences within the evidence-based scope of treatment. Thus, continuous and proper education and dental training should be offered to the dental practitioners (Ree et al., 2003).

Limitations of the study

One limitation of the study is the large number of questions and the limited length of time to complete the questionnaire. This might have caused disinterest at the four dental schools that did not take part in the survey.

A generalization of the results is difficult because different curricular regulations exist at each location (Germany, Austria and Switzerland). Moreover, dental schools in the German-speaking countries are also regulated (Federal Law Gazette (Bundesgesetzblatt), 2019; Zitzmann, 2017) and therefore easier to compare.

CONCLUSION

Preclinical education in Endodontology has evolved positively in some categories compared with the status based on former surveys. Improvements can be seen in the faculty-to-student ratio, the time dedicated to endodontic theory, and the use of contemporary and advanced materials and instruments, such as magnification aids or mechanical shaping with NiTi instruments. However, large divergences still exist amongst the dental schools concerning the time dedicated to theoretical and practical instruction, the employment of staff with advanced knowledge and skills in endodontics, and the students' competences in EbD. Nevertheless, the COVID-19 pandemic may have changed the preclinical education in Endodontology; therefore, it should be evaluated in future research.

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CONFLICT OF INTEREST

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

AUTHOR CONTRIBUTION

S. Sacha: Conceptualization (lead), Data collection, Data analysis and interpretation, writing – original draft (lead), writing – review and editing; D. Sonntag: Conceptualization (supporting), review and editing (equal); U. Burmeister: Conceptualization (supporting), review and editing (equal); S. Rüttermann: Conceptualization (supporting), review and editing (equal); S. Gerhardt-Szép: Conceptualization (lead), Writing – original draft (supporting), review and editing (equal).

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the Supporting Information section.

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