Original Article

Braz J Oral Sci.
April | June 2013 - Volume 12, Number 2

A survey on dental undergraduates' knowledge of oral radiology

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Abstract

Dentists' incorrect behavior with regards to Oral Radiology, as reported in the literature, has been related to inadequate training of undergraduates. **Aim:** This study assessed dental undergraduates' knowledge of Oral Radiology. **Methods:** A questionnaire containing 30 questions pertaining to three domains - General Principles, Radiobiology/Radioprotection and Technique/Interpretation - was used as data collection instrument. A total of 195 students answered the questionnaires. **Results:** No statistically significant differences were found between second-, third- and fourth-year students ($p>0.05$) when the whole questionnaire and the General Principles domain ($p>0.05$) were considered. The Technique/Interpretation domain presented a borderline statistical significance level ($p=0.051$), with more correct answers attributed to second-year students. A statistically significant difference ($p<0.05$) was seen for the Radiobiology/Radioprotection domain, in which the fourth-year students performed better. **Conclusions:** Dental undergraduates' knowledge of Oral Radiology did not increase or decrease significantly comparing the undergraduate years. However, with the exception of the Technique/Interpretation domain, students of more advanced undergraduate years answered more correctly the questions. Nevertheless, the Technique/Interpretation domain should be reinforced throughout the undergraduate course.

Keywords: dental education, radiology, dental radiography, radiation protection, questionnaires.

Introduction

Literature shows that many dentists have neglected not only the basic principles of radiology, but also certain national laws on radiograph application[1-6]. Inappropriate procedures mostly involve inadequate development of films, use of cone indicators, incorrect radiographic techniques, excessive exposure time, failure to protect patients during radiographic exposure, and improper disposal of processing solutions and lead foil[3]. These procedures result in radiographs of inadequate quality for diagnosis, higher radiation doses for patients and damage to the environment[3]. Some authors associate such failings with an inadequate training of undergraduates[3,7-8].

Currently, education of dental students is being discussed all over the world with a view to changes[9-12]. In Brazil, the Ministry of Education has proposed new Curriculum Guidelines for Dental Courses[10]. These Guidelines propose an interdisciplinary general graduation in dentistry. However, 10 years after the Guidelines were first proposed, little discussion has taken place in terms of education

Received for publication: February 25, 2013
Accepted: June 11, 2013

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on Oral Radiology. As an example, this subject is taught during a 1-year period in Brazilian undergraduate dental courses, although dental radiographs are taken throughout the whole undergraduate course.

Piracicaba Dental School and other Brazilian universities are implementing new curricula based on the above-mentioned Guidelines. Learning deficiencies must be assessed in order to propose methodological strategies and improve the course. With such a background, this study set out to investigate the development of Oral Radiology knowledge during an undergraduate dental course.

Material and methods

This cross-sectional study was conducted at the Piracicaba Dental School, University of Campinas, Piracicaba, SP, Brazil. Its design received full approval from the local Research Ethics Committee (protocol #095/2011) and the participants were second-, third- and fourth-year undergraduate students. First-year students did not participate because Oral Radiology is not a subject in their curriculum.

In order to evaluate the students' knowledge, a self-administered questionnaire containing 30 questions on Oral Radiology was applied at the end of the academic year. The Chart 1 shows the questionnaire with the answers considered correct. The questions pertained to three domains: General Principles, Radiobiology/Radioprotection and Technique/Interpretation. The questionnaire had been validated earlier according to the protocol described by Ferreira et al.[13] (2012). The students received the questionnaire after agreeing with their participation and giving their written informed consent. The questionnaire was not used for graduation purposes and the students were not obliged to fill it out.

Questions were answered with "True", "False", or "I don't know" statements. The aim of the "I don't know" statement was to prevent random responses by guessing the

Chart 1: Questions of the questionnaire applied and the respective correct answers. The students were asked to answer each question as "True", "False" or "I don't know".

Question	Response*
General Principles	
1. X-rays are electromagnetic radiation.	True
2. During examination, the x-ray operator must protect himself from the reflected rays.	False
3. The x-ray machine must be turned off when not in use in order to avoid inadequate x-ray emission.	False
4. It takes 5 seconds after an exposure to scatter radiation be dissipated.	False
5. It is not possible to generate x-rays without power supply.	True
6. The oil in the tube head is heated when the x-ray machine is turned on, even if no exposure is performed.	False
7. The room must be immediately isolated if a x-ray tube is broken.	False
8. A radiograph fixed within 15 seconds is adequate for diagnosis.	False
9. Covering the processing solutions can extend their usage time.	True
10. Rinse stops the action of the developer in the manual processing.	False
Radiobiology/Radioprotection	
11. Routine radiographic examination with a six-month interval cannot cause stochastic biological effects.	False
12. Radiographic examination in pregnant women must be performed only in the second trimester of pregnancy in order to reduce the chance of deleterious effects.	True
13. Protecting gonads from radiation is not necessary, because dental radiographs are taken in the head and neck region.	True
14. All human tissues have the same radiosensitivity.	False
15. Whole body low-intensity-fractionated irradiation is more dangerous than high-intensity-localized irradiation.	True
16. X-ray operators have minimal chance of somatic effects if they correctly adopt the radioprotection rules.	True
17. Barriers like lead walls are mandatory to ensure adequate protection for the operator.	False
18. An adequate maintenance of the x-ray machine results in better productivity, and protection for both operator and patient.	True
19. Parents should hold films in children's mouth if they do not cooperate during examination.	True
20. Periapical radiographs are strictly indicated for children only in cases of emergency.	False
Technique/Interpretation	
21. Bite-wing radiographs are indicated to investigate dental decay.	True
22. Oclusal radiographs are indicated to investigate bucco- lingual bone expansion.	True
23. Panoramic radiographs are indicated to investigate incipient caries lesions.	False
24. A full-mouth series (FMX) is indicated if many teeth are absent during physical examination.	False
25. An unerupted superior left-canine had dislocated coincidently with the x-ray tube in the Clark method. Therefore, it is localized in a palatal position.	True
26. An elliptical radioluscence in the apex of vital lower pre-molars with intact lamina dura probably refers to the mentual foramen.	True
27. A diffuse radiolucency in the mandibular body, apically to lower molars, may indicate an aggressive lesion named "Stafne bone defect".	False
28. Since it onset, dental decay is radiographically detected.	False
29. Multilocular ameloblastoma has a ground-glass appearance.	False
30. Tooth displacement and bone expansion are typical of malignant lesions.	False

answers. The SPSS software version 18.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis and the data were dichotomized into correct and incorrect answers (including the "I don't know" answers). The correct and incorrect frequencies were tested in relation to the students' year group, using the Chi-square test. These frequencies were also tested in relation to each of the three main domains of the questionnaire. Significance level was set at 5%.

Each undergraduate year group invited to participate in this study had approximately 80 students regularly enrolled in the undergraduate course, so the sample comprised a population of 240 potential respondents.

Results

The overall response rate was 81.2% (n = 195) and the final sample comprised 68 second-year (34.9%), 75 third-year (38.5%) and 52 fourth-year students (26.7%). The socio-demographic survey (Table 1) showed predominance of female students (74.4%) aged 20 to 23 years (67.1%), with a household income above five minimum wages (74.8%).

Table 1 – Demographics of students in study.

Variables		n (%)
Gender	Female	145 (74.4)
	Male	47 (24.1)
Age (years)	< 20	16 (8.2)
	20-23	131 (67.1)
	24-27	19 (9.7)
	> 27	2 (1.0)
Household income	Up to 1 MW	1 (0.6)
	From 1 to 2 MW	3 (1.8)
	From 2 to 4 MW	38 (22.8)
	From 5 to 10 MW	63 (37.7)
	Above 10 MW	62 (37.1)

MW = Minimum wage. Note: Several students left unanswered some questions of the sociodemographic survey.

Table 2 shows the percentage of correct and incorrect answers to the questionnaire. The chi-squared test did not show statistically significant difference between these values ($p > 0.05$).

Table 2 – Correct and incorrect answers *per* year group.

	2nd year n (%)	3rd year n (%)	4th year n (%)	Total n (%)
Incorrect	743 (36.4)	808 (35.9)	517 (33.1)	2,068 (35.3)
Correct	1,297 (63.6)	1,442 (64.1)	1,043 (66.9)	3,782 (64.7)
Total	2,040	2,250	1,560	5,850

χ^2=4.559 p=0.102

Analyzing the questions separately, Question 18 ("An adequate maintenance of the x-ray machine results in better productivity, and protection for both operator and patient") yielded the largest number of correct answers. On the other hand, Question 17 ("Barriers like lead walls are mandatory to ensure adequate protection for the operator") presented the largest number of incorrect answers. Question 11 ("Routine radiographic examination with a six-month interval cannot cause stochastic biological effects") was also answered incorrectly by most students.

Analyzing each questionnaire domain (Table 3), no statistically significant difference was found either for the General Principles or for the Technique/Interpretation domains ($p > 0.05$). In the General Principles domain, fourth-year students answered more questions correctly, while the second-year students performed better in the Technique/Interpretation domain. A statistically significant difference ($p < 0.05$) was seen for the Radiobiology/Radioprotection domain with more correct answers attributed to the fourth-year students.

Discussion

This study set out to investigate to what extent dental undergraduates' knowledge of Oral Radiology developed throughout their course. Brazil has the largest number of Oral Radiology courses and oral radiologists[14]. The incorrect behavior of dentists in terms of Oral Radiology is reported in the literature and it is correlated to a deficiency in the undergraduate education[3,7-8].

Various parameters are used to determine the effectiveness of education, namely student's performance, satisfaction, attitudes and skills, accomplishment of course goals and objectives, teachers' perceptions and evaluation of the course[15-16]. In this study, students' knowledge was evaluated by means of a self-applied questionnaire, a methodology also used in similar studies[17-19]. The questionnaire used in this research had been previously validated according to a protocol referred to in the literature[13]. The aim of this validation process was to obtain a trustworthy instrument for evaluation of the students. It included specialist's opinion in the field, pilot tests to verify students' understanding of the questions, consistency of data, and reproducibility of the questionnaire.

Undergraduates at advanced levels of a dentistry course have more study content than students at initial levels. Therefore, it is expected that the more advanced the student level, the better their knowledge of course content. In this study, fourth-year students answered more questions correctly than did either second- or third-year students. Since the questionnaire was not used to grade the students in levels, it is believed that the obtained results are close to the real situation and thereby provide a reliable evaluation of the students' knowledge. Some deficiencies were, however, detected for fourth-year students in relation to the specific domains evaluated in the study.

The General Principles domain presented uniform behavior throughout the course, with no statistically significant difference between the students ($p > 0.05$). The evaluated students answered correctly about 61 to 65% of this domain, showing satisfactory knowledge of the fundamentals of Oral Radiology.

Table 3 – Correct and incorrect answers *per* year group in relation to the questionnaire domains.

Domain		2nd year n (%)	3rd year n (%)	4th year n (%)	Total n (%)
General Principles	Incorrect	265 (39.0)	290 (38.6)	179 (34.4)	735 (37.7)
	Correct	415 (61.0)	460 (61.4)	341 (65.6)	1,215 (62.3)
	Total	680	750	520	1,950
χ^2=3.166 p=0.205					
Radiobiology/ Radioprotection	Incorrect	316 (46.5)	299 (39.8)	196 (37.6)	811 (41.6)
	Correct	364 (53.5)	451 (60.2)	324 (62.4)	1,139 (58.4)
	Total	680	750	520	1,950
χ^2=10.965 p=0.004					
Technique/ Interpretation	Incorrect	160 (23.5)	219 (29.2)	142 (27.3)	522 (26.7)
	Correct	520 (76.5)	531 (70.8)	378 (72.7)	1,428 (73.3)
	Total	680	750	520	1,950
χ^2=5.969 p=0.051					

Undergraduates' knowledge of the Radiobiology/ Radioprotection domain increased to a significant extent ($p < 0.05$). Since the second-year students had not studied this subject when the research was conducted, they produced more incorrect answers than other students. On the other hand, fourth-year students registered more correct answers than did third-year students. Such results strongly indicated that dental students showed a significant increase in their knowledge of radioprotection procedures and the consequences of exposure to radiation along the course. It is important to emphasize that only the Radiobiology/Radioprotection domain had not been taught to the second-year students when the questionnaire was applied.

The Technique/Interpretation domain showed a borderline statistical significance level ($p = 0.051$). Second-year students performed better than fourth-year students, which in turn, answered more questions correctly than did the third-year. Possibly, the second-year students answered more questions correctly because they had studied this subject just before the questionnaire was applied. Despite the decrease in the knowledge levels, as observed in the Technique/Interpretation domain, it presented the highest percentage of correct answers.

Dental radiographs are a valuable diagnostic tool for patient assessment and treatment planning in most clinical specialties of dentistry[20]. The obtained results demonstrated that third- and fourth-year students showed less knowledge of the Technique/Interpretation domain. These students are closest to entering the professional field and this lower knowledge should concern the clinical practice because a thorough knowledge of the various available radiographic modalities, their application, and accurate interpretation of the images and obtained data is necessary for the ethical and efficient practice of dentistry[20]. Question 29 ("Multilocular ameloblastoma has a ground-glass appearance") presented the highest percentage of incorrect answers in the Technique/ Interpretation domain.

Education systems worldwide are undergoing remarkable changes, as courses and programs are being designed in new ways[19], moving away from the passive teacher-centered to a more active learner-centered learning[21]. The Brazilian Guidelines for Dental Education[10] encourage a more active learner-centered learning. The literature has shown that this methodology presents better results in Oral Radiology[20]. Therefore, it can be suggest that an active learner-centered methodology be introduced in the evaluated school in order to improve students' knowledge of the Technique/ Interpretation domain.

It is important to emphasize that this was a cross-sectional study, which evaluated only one dental school, which means that the obtained results refer to a group of students who took part in the survey and, undoubtedly, there are differences between courses. Hence, further longitudinal investigations involving other dental schools are recommended to provide more data for discussion on education in Oral Radiology. Additionally, the present study evaluated only the students' theoretical knowledge and not their practical skills.

In conclusion, dental undergraduates' knowledge of Oral Radiology did not increase or decrease significantly comparing the first-, second- and fourth-year groups. However, except for the Technique/Interpretation domain, the more advanced the undergraduate year, the more correctly the students answered the questions. Nevertheless, we believe that the Technique/Interpretation domain needs to be reinforced throughout the course.

References

1. Aps JK. Flemish general dental practitioners' knowledge of dental radiology. Dentomaxillofac Radiol. 2010; 39: 113-8.
2. Jacobs R, Vanderstappen M, Bogaerts R, Gijbels F. Attitude of the Belgian dentist population towards radiation protection. Dentomaxillofac Radiol. 2004; 33: 334-9.
3. Shahab S, Kavosi A, Nazarinia H, Mehralizadeh S, Mohammadpour M, Emami M. Compliance of Iranian dentists with safety standards of oral radiology. Dentomaxillofac Radiol. 2011; 41: 159-64.

4. Svenson B, Söderfeldt B, Gröndahl HG. Attitudes of Swedish dentists to the choice of dental X-ray film and collimator for oral radiology. Dentomaxillofac Radiol. 1996; 25: 157-61.
5. Svenson B, Söderfeldt B, Gröndahl HG. Analysis of dentists' attitudes towards risks in oral radiology. Dentomaxillofac Radiol. 1996; 25: 151-6.
6. Tosoni GM, Campos DM, Silva MR. Frequency and quality management of intraoral radiographic examinations in private dental practices. Rev Odontol UNESP. 2003; 32: 25-9.
7. Melo MF, Melo SL. Radioprotection in dentistry offices. Cienc Saude Colet. 2008; 13(Suppl 2): 2163-70.
8. Neves FS, Vasconcelos TV, Bastos LC, Góes LA, Freitas DQ. Attitudes of dentists in relation to radiological protection, according to Brazilian law. Rev Odontol Bras Central. 2010; 19: 301-5.
9. Hendricson WD, Andrieu SC, Chadwick DG, Chmar JE, Cole JR, George MC et al. Educational strategies associated with development of problem-solving, critical thinking, and self-directed learning. J Dent Educ. 2006; 70: 925-36.
10. Brazil. Ministry of Education. National Council of Education. Resolution CNE/CES. Board of Higher Education. National Curriculum Guidelines for Undergraduate Dentistry. Official Federal Gazette; 2002 Mar 4.
11. Haden NK, Andrieu SC, Chadwick DG, Chmar JE, Cole JR, George MC et al. The dental education environment. J Dent Educ. 2006; 70: 1265-70.
12. Linjawi AI, Walmsley AD, Hill KB. Online discussion boards in dental education: potential and challenges. Eur J Dent Educ. 2012; 16: e3–9.
13. Ferreira NP, Batista MJ, Sousa MLR, Cury JA. Validation of the Questionnaire about Knowledge Cariology [in portuguese]; 2012 [in press].
14. Ruprecht A. The status of oral and maxillofacial radiology worldwide in 2007. Dentomaxillofac Radiol. 2009; 38: 98-103.
15. Olapiriyakul K, Scher JM. A guide to establishing hybrid learning courses: employing information technology to create a new learning experience, and a case study. Internet Higher Educ. 2006; 9: 287-301.
16. Handal B, Groenlund C, Gerzina T. Dentistry students' perceptions of learning management systems. Eur J Dent Educ. 2010; 14: 50-4.
17. Neuhaus KW, Schegg R, Krastl G, Amato M, Weiger R, Walter C. Integrate learning in dentistry: baseline data and first evaluation at the Dental School of Basel. Eur J Dent Educ. 2008; 12: 163-9.
18. Woltering V, Herrler A, Spitzer K, Spreckelsen C. Blended learning positively affects students' satisfaction and the role of the tutor in the problem-based learning process: results of a mixed-method evaluation. Adv Health Sci Educ. 2009; 14: 725-38.
19. Kavadella A, Tsiklakis K, Vougiouklakis G, Lionarakis A. Evaluation of a blended learning course for teaching oral radiology to undergraduate dental students. Eur J Dent Educ. 2012; 16: e88-95.
20. Kumar V, Gadbury-Amyot CC. A case-based and team-based learning model in oral and maxillofacial radiology. J Dent Educ. 2012; 76: 330-7.
21. Pahinis K, Stokes CW, Walsh TF, Tsitrou E, Cannavina G. A blended learning course taught to different groups of learners in a dental school: follow-up evaluation. J Dent Educ. 2008; 72: 1048-57.