RESEARCH ARTICLE

The assessment of adherence to infection control in oral radiology using newly developed and validated questionnaire (QICOR)

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Objectives: To assess the infection control in oral radiology among radiologists and dentists of diverse dentistry clinical specialties and among dentistry students.

Methods: A Questionnaire on Infection Control in Oral Radiology was applied to 1006 dentists and 1203 dentistry students. For assessment of infection control, the scores of the questionnaire were dichotomized in high and low through the median. Simple logistic regression models were set for adherence to infection control and independent variables, estimating the crude odds ratios with the respective 95% confidence intervals. The variables with $p < 0.20$ in the individual analyses were tested in multiple logistic regression models, remaining in the final model the variables with $p \leq 0.05$.

Results: Individual and adjusted association analysis showed that female dentists have 1.41 [95% CI: 1.08–1.84] more adherence odds to infection control when compared with males ($p < 0.05$). There was no significant association in regarding age, time of education in dentistry, an undergraduate degree from a public or private school, and work in public and/or private clinics. There were also no differences among radiologists and dentists of other clinical specialties. The students from the last year of the dental schools had 1.7 [95% CI (1.13–2.57)] more chances of less adherence to infection control ($p = 0.0001$). There was no significant association with respect to sex, age and public or private schools.

Conclusions: Educational procedures should be conducted in relation to infection control protocols in oral radiology, especially among male dentists, regardless clinic specialty, and among the students of the last year of the dental school.

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Introduction

Despite the development of new image methods, intra-oral radiographs remain the most used radiographic technique in dentistry,¹ acting as an important mean of complementary diagnose to clinical examination.²

On the other hand, this is the radiographic technique that offers the greater contamination risk between patients and professionals, due to the greater contact

with saliva and/or blood and, consequently, greater ease of contamination of work surfaces.^{2–6}

As a result of these factors, the Center for Disease Control and Prevention⁷ has developed a set of guidelines for dentistry in an attempt to prevent contamination between professionals and patients. Their guidelines include specific information on infection control in oral radiology, a topic which was also emphasized in their last publication.⁸ Among the recommendations are handwashing, use of individual protective equipment by the professionals (gloves, medical caps, masks, protective

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goggles, and lab coats), protection of image receptors with plastic barriers, and protection or disinfection of radiographic equipment surfaces.^{7,8}

However, despite the contamination risk of intraoral radiographs being known for approximately 40 years old⁹ and the existence of several studies that investigate ways to avoid contamination,^{2,4,5,10–14} little is known about the professionals' adherence to these recommendations.⁶

Studies that investigate the adherence to infection control in oral radiology, both in dentistry clinics,^{15,16} as well as in dental school,^{17,18} are scarce and antique, preceding the use of digital receivers. In these studies, questionnaires were used, but their psychometric properties (reliability and validity) were not evaluated.⁶ The importance of reliability and validation procedures should be highlighted, since they grant credibility and safety in questionnaire use, ensuring the level of understanding and the ability of the questionnaire in measuring the subject of interest.^{6,19}

Filling this gap in the literature, da Costa *et al*⁶ developed and validated a specific questionnaire for evaluation of infection control in oral radiology. Such questionnaire has the scientific consistency and properties necessary for the evaluation of the infection control performed by dentists, technicians in radiology and also by dentistry students.

Thus, the objective of this study was to assess the infection control in oral radiology among radiologists and dentists of different dentistry clinic specialties and also among dentistry students.

Methods and materials

This study was approved by the Research Ethics Committee of the Piracicaba Dental School of the University of Campinas (CAAE 50586415.0.0000.5418), and consent was obtained from each subject.

Samples of the dentists consisted of general clinician (who did not have graduate degree and/or title of specialists in the clinical area) and dentists who had graduate degree and/or specialization in a clinical area (aesthetic dentistry, endodontics, periodontics, surgery, implant dentistry, prosthesis, stomatology, orthodontics, collective health, paediatric dentistry, and oral radiology). Participating dentists were of both sexes, with at least 2 years of experience in dentistry clinics.

The sample of dentistry students were composed of students who were already involved in supervised clinical practice, or in their second, third, fourth and fifth years of dental school. In Brazil, school of dentistry is considered an undergraduate program and provided by public (without fee) and private (students pay a monthly fee or a system of funding is provided to them by the Government or by the institution itself) educational institutions.²⁰ In public and private institutions, the course is usually completed in a period of 4–5 years.

The approach to the study participants was made initially during an International Dentistry Congress,

annually held in São Paulo state and which attracts dental professionals and dentistry students from several localities of Brazil. In addition, the research was also conducted with dentists enrolled in graduate courses of a dentistry university in the state of São Paulo, and with randomly selected dentists in dentistry clinics of public and private services located in São Paulo state—Brazil.

Among dentistry students those attending the congress, students from 45 schools of dentistry (8 public and 37 private) participated in the study. In addition, showed interest in participating in the research more seven schools of dentistry in the state of São Paulo, Brazil (three private and four public). Thus, the total sample encompassed 52 school of dentistry (12 public and 40 private).

Thus, the final sample consisted of 1006 dentists and 1203 dentistry students, provided test power above 0.80, significance level of 5%, and odds ratio of 1.5.

For data collection, the Questionnaire on Infection Control in Oral Radiology (QICOR) was used, which was developed and validated by da Costa *et al*.⁶ (Table 1). It is observed that the maximum score that can be obtained by the questionnaire is 131 points and the minimum score of 24 points.

Each participant answered the questions individually, and the fill time ranged from 5 to 7 min. Each questionnaire received a numeric encoding, in such a way that the data were anonymously analyzed.

Data analysis

Initially, the sample was dichotomized into low scores (median ≤ 82 for the sample of the dentists, and median ≤ 80 for the sample of the students) and high scores (median > 82 for the sample of the dentists and median > 80 for the sample of the students). The categorization of the variables was done by the median, dividing the sample in low and high, in order to have balance and greater power of the test. Finally, a simple logistic regression model (individual analysis) was applied in order to analyze the association between scores of the QICOR and each independent variable. Variables with $p < 0.20$ in the individual analysis were selected for a multiple logistic regression model (adjusted analysis). In the final regression model, the variables with $p \leq 0.05$ remained. After adjusting the regression model, the values of odds ratio, their 95% confidence interval (CI), and p -values were estimated.

Posteriorly, it was constructed the box plot of the percentage of the scores in relation to the maximum possible (131 points) of QICOR of according to the sex (for the sample dentists) and for the undergraduate degree period (for sample of students).

For the individual evaluation of the frequency of infection control of each of the questions, the scores attributed to each response option (Table 1) were categorized as “excellent”, “reasonable” and “poor” (Table 2).

Already for qualitative variables (question on domains concerning the use of overgloves) in which

Table 1 QICOR

DOMAIN 1—HANDWASHING

- (1) Before putting on gloves, do you wash your hands?
- (2) (5) Always (4) usually (3) sometimes (2) rarely (1) never. (a) I perform disinfection with 70% alcohol.
- (3) After removing gloves, do you wash your hands?
- (4) (5) Always (4) usually (3) sometimes (2) rarely (1) never. (a) I perform disinfection with 70% alcohol.

DOMAIN 2—GLOVES

- (1) Indicate the frequency with which you use procedure gloves during radiographic exposure.
- (2) (5) Always (4) usually (3) sometimes (2) rarely (1) never. (a) Does not apply.

DOMAIN 3—CLOTHING

- (1) During radiographic exposure, indicate the frequency with which you use the following items: (a) Mask; (b) surgical cap; (c) medical coat.
- (2) (5) Always (4) usually (3) sometimes (2) rarely (1) never. (a) Does not apply.

DOMAIN 4—ACCESSORIES

- (1) During radiographic exposure, please indicate the frequency with which you use protective over-gloves.
- (2) (5) Always (4) usually (3) sometimes (2) rarely (1) never. (a) Does not apply.
- (3) How often do you sterilize the radiographic film-holding device for each patient?
- (4) (5) Always (4) usually (3) sometimes (2) rarely (1) never. (a) I do not use a film-holding device.

DOMAIN 5—RADIOGRAPHIC RECEPTORS

- (1) How often do you use a plastic barrier to pack intraoral films?
- (2) (5) Always (4) usually (3) sometimes (2) rarely (1) never. (a) I use only digital radiographic receptors.
- (3) How often do you use plastic protections to pack the digital radiographic receptor (phosphor plate/digital sensor)?
- (4) (5) Always (4) usually (3) sometimes (2) rarely (1) never. (a) I use only traditional film.

DOMAIN 6—PROTECTION/DISINFECTION OF RADIOGRAPHIC EQUIPMENT

- (1) During radiographic exposure, indicate the frequency with which you use the following items: (a) Headrest; (b) X-ray tube head (position-indicating device); (c) exposure button; (d) X-ray control panel; (e) computer monitor for the digital radiography system; (f) computer keyboard for the digital radiography system; (g) mouse for the digital radiography system
- (2) (5) Always (4) usually (3) sometimes (2) rarely (1) never. (a) Does not apply.
- (3) Indicate the infection control procedures you perform on the following devices for each new patient: (a) X-ray tube head (position-indicating device); (b) exposure button; (c) X-ray control panel; (d) patient's chair.
- (4) Disinfection with 70% alcohol + common cleaning (water and soap)+ plastic barrier/overgloves.
- (5) Disinfection with 70% alcohol + plastic barrier/overgloves.
- (6) Common cleaning (water and soap) + plastic barrier/overgloves.
- (7) Plastic barrier/overgloves.
- (8) Disinfection with 70% alcohol + common cleaning (water and soap).
- (9) Disinfection with 70% alcohol.
- (10) Common cleaning (water and soap).
- (11) I do not clean.
- (a) Other.

DOMAIN 7—OVERGLOVES

- (1) Indicate in which of the following situations you use overgloves: To place patients in the chair (a) yes (a) no.
- (2) To place X-ray apron and thyroid collar on the patient (a) yes (a) no.
- (3) To handle the X-ray tube head (position-indicating device) (a) yes (a) no.
- (4) To select the time on the control panel display (a) yes (a) no.
- (5) To press the exposure button (a) yes (a) no.
- (6) To handle radiographic film or digital radiography receptors not contaminated with saliva (a) yes (a) no.
- (7) To process the radiographic film (a) yes (a) no.

DOMAIN 8—OVERGLOVES: DIGITAL RADIOGRAPHY SYSTEM

- (1) Indicate in which of the following situations you use overgloves:
 - When using the computer for the digital radiography system (a) yes (a) no.
- To handle the monitor, keyboard, mouse, and/or printer of digital radiography system (a) yes (a) no.

DOMAIN 9—CLEANING AND DISINFECTION

- (1) Indicate how often do you clean and/or disinfect the following items: (a) patient's chair; (d) X-ray Apron (c) thyroid collar.
- (2) (5) Every patient (4) once a day (3) once a week (2) once a month (1) I do not know (a) other.
- (3) What types of disinfectants do you usually use to clean the radiography equipment (headrest, X-ray tube head (position-indicating device), exposure button, X-ray control panel, patient's chair, X-ray apron, thyroid collar)?
- (4) (a) Chlorine compounds (3) (b) 70% Alcohol (2) (c) Common cleaning (water and soap) (1) (d) I do not use disinfectants (a) (e) other.

Adapted by da Costa *et al*.⁶

QICOR, Questionnaire on Infection Control in Oral Radiology.

In parentheses are the scores for each answer option.

^aAnswer options to which scores were not attributed.

Table 2 Interpretation of the categories assigned to the scores for evaluation of individual infection control of each of the questions of the QICOR

Questions	Scores	Categories		
		Excellent	Reasonable	Poor
(1) Before putting on gloves, do you wash your hands?				
(2) After removing gloves, do you wash your hands?				
(3) During radiographic exposure, indicate the frequency with which you use procedure gloves?				
4. During radiographic exposure, indicate the frequency with which you use the following items: (a) mask; (b) surgical cap; (c) medical coat				
(1) During radiographic exposure, please indicate the frequency with which you use protective overgloves?				
(2) How often do you sterilize the radiograph film-holding device for each patient?				
(3) How often do you use plastic barrier to pack intraoral films?				
(4) How often do you use plastic protections to pack the digital radiographic receptor (phosphor plate/digital sensor)?				
(5) During radiographic exposure, indicate the frequency with which you use the following items: (a) headrest; (b) X-ray tubehead (position-indicating device); (c) exposure button; (d) X-ray control panel; (e) computer monitor for the digital radiography system; (f) computer keyboard for the digital radiography system; (g) mouse for the digital radiography system.				
(6) Indicate how often do you clean and/or disinfect the following items: (a) patient's chair; (d) X-ray Apron (c) thyroid collar.	Scores up to 5	5 and 4	3	2 and 1
10. Indicate the infection control procedures you perform on the following devices for each new patient: (a) X-ray tubehead (position-indicating device); (b) exposure button; (c) X-ray control panel; (d) patient's chair.	Scores up to 8	8 to 6 ^a	5 to 2 ^b	1
14. What types of disinfectants you usually use to clean the radiography equipment (headrest, X-ray tubehead (position-indicating device), exposure button, X-ray control panel, patient's chair, X-ray apron, thyroid collar)?	Scores up to 4	4 and 3 ^b	2 ^c	1

QICOR, Questionnaire on Infection Control in Oral Radiology.

^aAssociation between plastic barrier and use of disinfectant/cleaning.

^bUse of disinfectant solution.

^cCommon cleaning procedure (mechanical removal of contamination).

scores were not attributed, a descriptive analysis of data was performed.

Statistical analyses were performed using the Statistical Analysis System software, SAS® v. 9.2 (SAS Institute Inc., Cary, NC).

Results

A total of 2209 volunteers participated in the study, among them 1006 dentists and 1203 dentistry students. Table 3 presents the characteristics of the sample of dentists and students.

The sample of the dentists, showed that males had lower score regarding infection control, considering that females had 1.41 [95% CI: 1.08–1.84] times greater adherence odds to infection control when compared with males ($p < 0.05$). While for the sample of the students, the analysis of association between the total score and the analyzed variables indicated that students attending the fifth year had 1.70 [95% CI: (1.13–2.57)] more chances of lower adherence to infection control ($p = 0.0001$) (Table 4).

Therefore, the percentage of the total score, in relation to the maximum possible (131 points), it was verified that the male dentists had lower scores, with a

median of 61.1% ranging from 29.8 to 94.7% (Figure 1), and for the sample of students, it was observed that fifth year students presented lower values, with a median of 55.7%, varying from 22.9 to 91.6% (Figure 2).

The individual analysis of the frequency of infection control for each of the questions/items of the QICOR showed that most dentists and students had “excellent” infection control for issues related to domains “hand-washing”, “gloves”, “clothing” and “radiographics receptors”. Infection control was “reasonable” for the type of procedure to control infection (plastic barrier or disinfection/cleaning) of the surfaces of radiographic equipment and patient's chair. While infection control was “poor” for plastic barrier protection of the keyboard and mouse, and cleaning and/or disinfecting the X-ray apron and thyroid collar (Supplementary Material 1).

For the answer options “others” (Question 10—“protection/disinfection of radiographic equipment and patient's chair”, and Question 14—“disinfectants used”), the dentists and students responded that they used other disinfectant solutions (not listed in the response options of the questionnaire). Besides, some students reported who they performed the procedures of infection control on the radiographic equipment only when attending the oral radiology discipline, others reported believing this procedure was carried out by the cleaning staff and others some mentioned that they worked in pairs (with one of the students acting as an

Table 3 Profile of sample of dentists (n = 1006) and of the sample of dental students (n = 1203)

<i>Sample</i> <i>Variables</i>	<i>Dentists</i>				
	<i>General clinician</i>	<i>Specialists</i>	<i>Radiologists</i>	<i>Total</i>	
N (%)	409 (40.6)	534 (53.1)	63 (6.3)	1006 (100.0)	
Sex					
Female (%)	294 (43.2)	344 (50.6)	42 (6.2)	680 (67.6)	
Male (%)	115 (35.3)	190 (58.3)	21 (6.4)	326 (32.4)	
Undergraduate degree					
Public (%)	116 (27.2)	264 (62.0)	46 (10.8)	426 (42.3)	
Private (%)	283 (50.3)	263 (46.7)	17 (3.0)	563 (56.0)	
Not informed (%)	10 (58.8)	7 (41.2)	–	17 (1.7)	
Time since graduation in dentistry (SD)	11.1 (10.5)	11.3 (9.7)	7.5 (6.8)	11.3 (10.1)	
Service jobs					
Public (%)	99 (51.8)	81 (42.4)	11 (5.7)	191 (18.9)	
Private (%)	233 (43.8)	278 (52.2)	21 (4.0)	532 (52.9)	
Public and private (%)	37 (33.3)	72 (64.9)	2 (1.8)	111 (11.0)	
Others ^a	12 (75.0)	4 (25.0)	–	16 (1.6)	
Currently enrolled in a graduate-level studies (%)	28 (17.9)	99 (63.5)	29 (18.6)	156 (15.5)	
Age (SD)	34.1 (10.7)	33.9 (10.3)	28.8 (6.5)	33.6 (9.8)	
Sample	Students				
	2nd year	3rd year	4th year	5th year	Total
N (%)	178 (14.8)	437 (36.3)	388 (32.3)	200 (16.6)	1203 (100)
Sex					
Female (%)	126 (13.9)	313 (34.6)	313 (34.6)	153 (16.9)	905 (75.2)
Male (%)	52 (17.4)	124 (41.6)	75 (25.2)	47 (15.8)	298 (24.8)
Undergraduate degree					
Public (%)	69 (11.0)	218 (34.8)	154 (24.5)	186 (29.7)	627 (52.1)
Private (%)	109 (19.0)	219 (38.0)	234 (40.6)	14 (2.4)	576 (47.9)
Age (SD)	22.0 (4.5)	22.6 (5.2)	23.6 (3.9)	23.7 (3.0)	23.0 (4.1)

SD, standard deviation.

^aDentists who were not working.

assistant by handling the radiographic equipment and not ever touching the patient's oral cavity) ([Supplementary Material 2](#)).

The questions of domains regarding the use of overgloves (“overgloves” and “Overgloves: Digital Radiographic System” domains), it was verified the low use among dentists (<15%). It was observed among the students more frequent use for “pressing the exposure button” (14.5 to 34.3%) ([Supplementary Material 3](#)).

Discussion

Intraoral radiographs are one of the most required radiographic exams by dentists,¹ being also recognized as the examination that most exposes the dentistry team to cross-contamination.^{2–6} Thus, the present study aimed to assess the infection control in oral radiology carried out by dentists and dentistry students.

Among of the dentists, the adherence odds to infection control were only significantly affected by the sex variable, since males showed a smaller chance of adherence to infection control. Such a finding is consistent

with previous studies, which found that females showed a better hygiene pattern, although related to hand hygiene^{21–23} and use of personal protection equipment.²⁴

Professional variables (time since graduation, enrollment in graduate-level studies, specialty, employment in public or private service jobs) and the age variable did not significantly affect the adherence odds to infection control. Thus, despite the longer time of education among dentists, which suggest greater clinical experience, this fact did not influence in adherence odds to infection control in oral radiology. Yet, according to Cleveland et al,²⁵ the clinical experience is not a factor that contributes to greater adherence to infection control. What really contributes is the instruction received about infection control protocols.

Aiming at a further analysis regarding knowledge on infection control, this study highlighted the specialty in oral radiology, since was assumed this group possessed, at the same time, greater knowledge on the procedure for infection control and greater experience regarding the application of these protocols in their daily clinical activities. However, the results showed that even in this

Table 4 Individual and adjusted analyses for the score on QICOR for the sample of dentists and students

<i>Dentists</i>								
<i>Variable</i>	<i>Category</i>	<i>N (%)</i>	<i>Sum of the scores</i>		<i>^bGross OR (^c95% CI)^d</i>	<i>p-value</i>	<i>Adjusted OR (95% CI)^e</i>	<i>p-value</i>
			<i>≤median (82)^a</i>	<i>>median (82)</i>				
		<i>N (%)</i>	<i>N (%)</i>					
Age	≤Median (30)	521 (51.8)	261 (50.1)	260 (49.9)	1.06 (0.83–1.36)	0.6218	–	
	>Median (30)	485 (48.2)	250 (51.6)	234 (48.4)	Ref			
Sex	Female	680 (67.6)	327 (48.1)	353 (51.9)	1.41 (1.08–1.84)	0.0116	1.41 (1.08–1.84)	0.0116
	Male	326 (32.4)	184 (56.6)	141 (43.4)	Ref		Ref	
Time since graduation in dentistry	≤Median (7)	536 (53.3)	270 (50.4)	266 (49.6)	1.04 (0.81–1.33)	0.7487	–	
	>Median (7)	470 (46.7)	241 (51.4)	228 (48.6)	Ref			
Dental school	Public	426 (43.0)	218 (51.3)	207 (48.7)	Ref		–	
	Private	563 (57.0)	281 (49.9)	28 (50.1)	1.06 (0.82–1.36)	0.6669		
Graduate degree in the clinic area	Yes	597 (59.3)	317 (53.2)	279 (46.8)	Ref		–	
	No	409 (40.7)	194 (47.4)	215 (52.6)	1.26 (0.98–1.62)	0.0734		
Graduate degree in radiology	Yes	63 (6.3)	29 (46.8)	33 (53.2)	1.19 (0.71–1.99)	0.5087	–	
	No	943 (93.7)	482 (51.1)	461 (48.9)	Ref			
Currently enrolled in a graduate-level studies	Yes	157 (15.6)	85 (54.1)	72 (45.9)	Ref		–	
	No	849 (84.4)	426 (50.2)	422 (46.8)	1.17 (0.83–1.64)	0.3700		
Service jobs	Public	191 (22.8)	100 (52.6)	90 (47.4)	Ref		–	
	Private	532 (63.9)	269 (50.6)	263 (49.4)	1.09 (0.78–1.51)	0.1559		
	Private and public	111 (13.3)	49 (44.1)	62 (55.9)	1.41 (0.88–2.25)	0.2192		
<i>Students</i>								
			<i>≤Median (80)^a</i>	<i>>Median (80)</i>				
		<i>N (%)</i>	<i>N (%)</i>					
Age	≤Median (22)	724 (60.2)	348 (48.1)	376 (51.9)	Ref		–	
	>Median (22)	479 (39.8)	255 (53.2)	224 (46.8)	1.23 (0.98–1.55)	0.0796		
Sex	Female	905 (75.2)	464 (51.3)	441 (48.7)	1.20 (0.93–1.56)	0.1667	–	
	Male	298 (24.8)	139 (46.6)	159 (53.4)	Ref			
Period of the course in dentistry	2nd	178 (14.8)	90 (50.6)	88 (49.4)	Ref		Ref	
	3rd	437 (36.3)	194 (44.4)	243 (55.6)	0.78 (0.55–1.11)	0.1903	0.78 (0.55–1.11)	0.1903
	4th	388 (32.3)	192 (49.5)	196 (50.5)	0.96 (0.67–1.37)	0.2801	0.96 (0.67–1.37)	0.2801
	5th	200 (16.6)	127 (63.5)	73 (36.5)	1.70 (1.13–2.57)	0.0001	1.70 (1.13–2.57)	0.0001
	Dental school							
	Public	627 (52.1)	329 (52.5)	298 (47.5)	1.22 (0.97–1.53)	0.0897	–	
	Private	576 (47.9)	274 (47.6)	302 (52.4)	Ref			

CI, confidence interval; OR, odds ratio; QICOR, Questionnaire on Infection Control in Oral Radiology.

^aReference level.^bOdds ratio.^cConfidence interval.^dSimple logistic regression model.^eMultiple logistic regression model.

group there were no greater adherence odds to infection control.

Still regarding dentistry specialties, the absence of significant difference in adherence odds to infection

control, among dentists with specialization in clinical areas and general clinicians, was also observed in previous studies such as a hand hygiene-related study²⁶ and in dentistry clinics.²⁴

Figure 1 Box plot of percentage of the scores (in relation to the maximum possible score) of QICOR of according with sex. QICOR, Questionnaire on Infection Control in Oral Radiology.

For the sample of students, it was verified that the students of the last year (fifth year) were the ones that had more chance of less adherence to the control of infection in radiology. These results are worrisome, as these students will soon become active in the labour market.

It is observed that usually the topic of infection control in radiology is addressed at the beginning of the discipline, during the first few years of the course in dentistry. Thus, it may be suggested that students in the last year had lower adherence to infection control probably because they had a longer period had elapsed since they had first attended the discipline of radiology. This can be justified through the answers of some of the participants of this study, who reported performing the infection control procedures on the surface of the radiographic equipment more diligently while attending the discipline of radiology.

Figure 2 Box plot of percentage of scores (relative to the maximum possible score) of QICOR per period of course in dentistry. QICOR, Questionnaire on Infection Control in Oral Radiology.

These results demonstrate the need for continuing education and for actions of incentive to the practice of infection control. In this sense, the key role of professors as professional role models who stimulate students to assume their active and responsible role in preventing contamination is verified.

The individual analysis of the questionnaire's questions/answer options allowed observing that the dentists and students infection control behaviour were focused on self-protection, as they scored "excellent" in the questions related to handwashing and to the use of personal protective equipment.

The protection frequency of digital radiography receptor with plastic barriers was slightly higher than the protection of conventional films (72.0% for dentists and 90.2% for students). In the specific case of digital radiography receptor, the recommendation is that they should be exclusively protected by plastic barriers, since they cannot be autoclaved,¹⁰⁻¹⁴ and are also sensitive to the use of disinfectants,¹² while conventional films can alternatively be disinfected.⁷ Thus, in the present research the dentists and students indicated to be correctly following the guidelines for the control of infection of the digital radiography receptor.

For the other items associated with the digital system (keyboard and mouse), infection control with the use of plastic barriers was "poor". As these surfaces are manipulated during intraoral radiographic examination, they must also be protected with plastic barriers to avoid cross-contamination.^{7,8} Thus, although dentists and students protect digital radiography receptor, there is a failure of the aseptic chain in the items used during digital image acquisition.

Infection control was also "poor" for protection with plastic barriers from the surface of the radiographic equipment and patient's chair. However, for the issues that combined the use of plastic barriers and/or disinfection/cleaning, the infection control was "reasonable". It should be noted that the infection control protocols recommend the associated use of the plastic barrier, followed by disinfection. However, for the items related to the digital system, the use of disinfectant solution is not recommended, as these devices are sensitive to these solutions.^{7,8}

Thus, it may be suggested that the dentists of the present study prefer to use disinfectant solutions to control infection of surfaces, as the frequency of use of disinfectants was higher than 80% for dentists and 66.6% for students.

An alternative to surface protection/disinfection of surfaces, the dentists could use overgloves (plastic gloves that cover the procedure gloves), which enable the dentist to handle surfaces not protected by plastic barriers. However, the results of the present study showed that dentists had a low frequency of use of the glove, being slightly higher among students.

Also as justification to the non-protecting/disinfecting of surfaces, students reported that they believed it was the cleaning staff's responsibility. However, seeing

as the cleaning staff carries out their job at the end of the day only, and the radiographic equipment can be used multiple times by different students and for different patients in the same period. It should be observed that health protection entities guide the protection or disinfection of surfaces with each new patient.^{7,8}

Still regarding the questions related to protection with plastic barriers and disinfection of surfaces, some of the students justified in the answer option “other”, that they do not carry out the procedures of protection of the radiographic equipment’s surfaces because they work alongside an assisting peer. However, it is interesting to note that even in these situations it is important that the infection control procedures are carried out, because the saliva of the patient can come into contact with the lead apron and thyroid collar during the radiographic examination. The results showed that infection control for these surfaces was “poor” for both students and dentists.

Infection control was also “poor” for disinfection frequency of the X-ray apron and thyroid collar. It is observed the importance of performing infection control procedures in these items, because in the same way the radiographic equipment, these surfaces can be contaminated with saliva/blood spatter of the patient and become a potential reservoir for microorganisms.²⁻⁶

A study on contamination of X-ray aprons confirmed the presence of pathogenic microorganisms such as the *Staphylococcus aureus*.²⁷ Although such study was carried out in an imaging department of a hospital, it serves as a warning about the importance of performing infection control protocols in all surfaces of healthcare environments.

Accordingly, previous studies also showed the presence of *Staphylococcus aureus* on the surface of X-ray equipment²⁸ as well as patient contamination by other opportunistic microorganisms (*Staphylococcus epidermidis* and *Streptococcus mitis*) after radiographic examination.⁹ Thus, the presence of pathogenic microorganisms in the X-ray equipment, X-ray apron, and thyroid collar can be harmful especially for immunocompromised patients as well as for the dentistry team that frequently handles such surfaces during the radiographic examination.

This research presented an overview of infection control in oral radiology performed by dentists and students from different periods of the course in dentistry. Because of the relevance of intraoral X-rays as a complement to dentistry clinical examination,²⁹ it is important that infection control procedures are incorporated by dentists and reinforced to students throughout the course in dentistry.

Thus, it is essential to emphasize to dentists and students that the dentist is responsible for all aspects of the radiographic examination, from the knowledge of radiographic technique and interpretation, to the patient’s protection, either through radioprotection, or through infection control procedures. Dentists and students need to be aware that the infection control protocols should be part of their work routine, and given the same importance of technical knowledge for the conducting of intraoral radiographic examinations.

Conclusion

The questionnaire allowed to evaluate the infection control in oral radiology, indicating the need to implement educational and awareness strategies on the importance of infection control, especially among male dentists, regardless clinic specialty, and mainly among students of the last year of the dental school, aiming to prevent cross contamination between the dental team and patients.

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