



CLINICAL RESEARCH:

Assessment of Knowledge in Adherence to Infection Control During Radiographic Procedures Among Dental Students and Dental Practitioners

Evaluación del conocimiento en la aplicación del control de infecciones durante los procedimientos radiográficos entre estudiantes de odontología y profesionales dentales

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Received: 22-VIII-2025

Accepted: 3-X-2025

ABSTRACT: Infection control in oral radiology is essential for preventing cross-contamination, but compliance differs among dental professionals. This study assessed knowledge and adherence to infection-control measures during radiographic procedures among dental students and practitioners. A cross-sectional questionnaire survey was conducted among 392 participants (students and practitioners). The validated tool covered domains of hand hygiene, personal protective equipment (PPE), protective over gloves, sterilization, and use of plastic barriers. Descriptive statistics summarized practices. Pearsons χ^2 tested between-group differences, and binary logistic regression was performed to identify predictors of adherence. Statistical significance was set at $p < 0.05$. Only 39.0% of participants demonstrated adequate adherence ($\geq 70\%$ of practices followed). Adequacy was slightly higher among students (39.8%) than among practitioners (36.6%). Logistic regression showed that students had significantly higher odds of PPE use (OR 1.72, 95% CI 1.40-2.11), sterilization of devices (OR 1.61, 95% CI 1.32-1.98), and plastic barrier use (OR 1.65, 95% CI 1.34-2.02). No significant differences were found between hand hygiene and over-glove use. Both students and practitioners demonstrated only moderate adherence to infection-control practices in radiology, with notable gaps in pre-glove hand hygiene and protective over-glove use. To strengthen consistent infection-control measures, targeted training for practitioners and curriculum reinforcement for students are recommended.



KEYWORDS: Infection control; Oral radiology; Dental students; Dentists; Hand hygiene; Personal protective equipment; Sterilization.

RESUMEN: El control de infecciones en la radiología oral es esencial para prevenir la contaminación cruzada, pero la adherencia varía entre los profesionales dentales. Este estudio evaluó el conocimiento y la adherencia a las medidas de control de infecciones durante los procedimientos radiográficos entre estudiantes de odontología y dentistas en ejercicio. Se realizó una encuesta transversal en 392 participantes. El cuestionario validado incluyó dominios de higiene de manos, equipo de protección personal (EPP), uso de sobre-guantes, esterilización y uso de barreras plásticas. Se empleó estadística descriptiva para resumir las prácticas, la prueba χ^2 de Pearson para comparar grupos y regresión logística binaria para identificar predictores de adherencia. Se consideró significativo un valor de $p < 0.05$. Solo el 39,0% de los participantes mostró adherencia adecuada ($\geq 70\%$ de las prácticas). La adherencia fue ligeramente mayor en los estudiantes (39,8%) que en los profesionales (36,6%). La regresión logística mostró que los estudiantes tuvieron mayores probabilidades de usar EPP (OR 1.72; IC 95% 1.40-2.11), esterilizar dispositivos (OR 1.61; IC 95% 1.32-1.98) y usar barreras plásticas (OR 1.65; IC 95% 1.34-2.02). No se hallaron diferencias significativas en la higiene de manos ni en el uso de sobre-guantes. Tanto estudiantes como profesionales demostraron una adherencia moderada, con brechas notables en la higiene de manos antes del uso de guantes y en el empleo de sobre-guantes. Se recomienda capacitación específica para profesionales y refuerzo curricular para estudiantes a fin de fortalecer la aplicación consistente de las medidas de control de infecciones en radiología.

PALABRAS CLAVE: Control de infecciones; Radiología oral; Estudiantes de odontología; Dentistas; Higiene de manos; Equipo de protección personal; Esterilización.

INTRODUCTION

With more than 700 different kinds of bacteria, fungi, viruses, and protozoa, the oral cavity is home to the second-largest and most diverse microbiota after the gut. These microbes can colonize both the soft oral tissues and the hard tooth surfaces because of the special conditions found in the mouth (1,2). Infection control procedures started when Pasteur, Koch, and Lister discovered nosocomial infections (3,4). To avoid cross-contamination, dental offices must maintain stringent infection control (5)

Infection control within dental practice requires meticulous attention to various domains. Hand hygiene prior to donning and subsequent to

removing gloves is considered the most effective preventative measure against cross-infection. The sterilization of radiographic film-holding devices and digital sensors, coupled with the use of protective plastic barriers, is essential to prevent contaminant transfer to radiographic equipment. Non-compliance with these protocols could lead to cross-contamination between patients and dental practitioners.

The U.S. Centers for Disease Control and Prevention (CDC) provides detailed recommendations for infection control in dental healthcare settings, including radiographic procedures (6). Similarly, the American Dental Association (ADA) emphasizes the use of barriers and sterilization for intraoral radiography (7), while the World Health

Organization (WHO) highlights global standards for hand hygiene and PPE compliance in clinical environments (8).

Costa *et al.* created the pre-validated Questionnaire on Infection Control in Oral Radiology (QICOR). It is intended especially to evaluate oral radiologists' understanding of and compliance with infection control procedures. Researchers can gain insights into infection control procedures by using the QICOR, identifying potential improvement areas, and encouraging improved cleanliness (9).

Previous research has shown variability in knowledge and adherence across populations. Cheng *et al.* reported that hand hygiene compliance in a dental teaching hospital was as low as 34.7% in general practice but exceeded 90% in surgical settings, indicating that training and environment strongly influence adherence. (10) Vega *et al.* found that dentists and dental specialists had comparable knowledge levels regarding hand hygiene, though gaps persisted in actual practice (11). Similar European and Asian studies have also noted that dental students often demonstrate higher adherence to PPE use and equipment sterilization than practitioners, possibly due to recent formal training (4,5).

This study was conducted to determine the level of knowledge and adherence to infection control practices in oral radiology among dental practitioners and dental students. It identifies a research gap concerning insufficient data comparing understanding and compliance with infection control practices in oral radiology. By exploring this gap, the study aims to offer essential insights into areas requiring enhancement and assist in creating focused strategies to improve infection control practices in dental radiology.

MATERIALS AND METHODS

STUDY SETTING

The cross-sectional study was conducted at a private Dental College, after obtaining clearance from the Institutional Research Committee of the institution (IRC/262729022024/S/15) in February 2024. A pre-validated tool, the *Questionnaire on Infection Control in Oral Radiology* (QICOR), developed by Costa *et al.* (6, 7) was used for data collection. The study employed a convenience sampling method, as participation was voluntary and invitations were distributed electronically through institutional networks. Data collection was carried out over a 6-week period (January-February 2024). The validated questionnaire was sent to the selected participants via Google Forms to gather responses efficiently. This study was conducted in accordance with the Helsinki Declaration. Written consent of participants was obtained.

SAMPLE SIZE ESTIMATION

A total of 420 individuals were approached, and 392 provided complete responses, resulting in a response rate of 93.3%. The sample size was determined using the G*Power statistical software, version 3.1.9.2. Based on an expected moderate effect size (Cohen's $w=0.3$), $\alpha=0.05$, and power $(1-\beta)=0.80$ for χ^2 analysis, the minimum required sample was calculated as 390.

METHODOLOGY

INCLUSION CRITERIA: The study included third- and fourth-year undergraduate students, Interns, and Post-graduate students pursuing advanced dental specialties. Also, Dental practitioners within the state with significant clinical experience were included.

EXCLUSION CRITERIA: Non-dental professionals, dental students below third year, and practitioners with less than five years of experience and who reside outside the state were not included. Participants with incomplete or invalid responses were excluded from the analysis. Missing data within otherwise valid responses were handled using listwise deletion.

QUESTIONNAIRE DEVELOPMENT

QICOR is made up of 25 items spread across four domains: (1) demographics, (2) knowledge of infection control measures, (3) adherence to infection control practices, and (4) attitudes toward infection control. The items feature multiple-choice, yes/no, and Likert-scale questions. We scored knowledge as “1” for correct answers and “0” for incorrect ones, and adherence was measured in percentages. Overall performance was classified as adequate or inadequate based on a cutoff of 70% or higher, aligning with previous validation studies (Costa 2018; Costa 2017).

DATA ANALYSIS

All analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including frequencies and percentages, were used to summarize the findings. To assess the knowledge and adherence to infection control practices in oral radiology procedures among dental practitioners and students, and to compare these groups, the Pearson chi-square test (χ^2) for independence was applied. Additionally, binary logistic regression analysis was conducted to identify variables influencing knowledge and adherence. A p-value of <0.05 was considered statistically significant. Odds ratios (OR) with 95% confidence intervals

(CI) were reported for logistic regression results.

RESULTS

This study assessed the infection control practices among dental students and practitioners, focusing on adherence to recommended protocols during radiographic procedures.

DEMOGRAPHICS AND EXPERIENCE

Student Categories: A significant majority of participants are dental students (n=299, of which 104 are Interns, 39 are Postgraduates, 97 are UG Final Year, and 59 are UG third Year) compared to practitioners (93), with a clear emphasis on early-career individuals. The Chi-square value of 4 and a p-value of 0.000* indicate a strong association between being a student and the practice of infection control.

Overall knowledge and adherence scores were categorized as adequate or inadequate using a $\geq 70\%$ cutoff (Table 1).

Table 1. Overall knowledge and adherence levels.

Knowledge/ Adherence Level	Students n (%)	Practitioners n (%)	Total n (%)
Adequate	119 (39.8%)	34 (36.6%)	153 (39.0%)
Inadequate	180 (60.2%)	59 (63.4%)	239 (61.0%)

Only ~40% of both students and practitioners demonstrated adequate adherence ($\geq 70\%$ practices followed). There was no major difference between the two groups (students 39.8% vs practitioners 36.6%). The majority (over 60%) in both groups had inadequate adherence overall.

DOMAIN-SPECIFIC PRACTICES

HAND HYGIENE PRACTICES

BEFORE WEARING GLOVES: Only 47 dental practitioners reported always washing their hands before putting on gloves, compared to 133 dental students. The correlation coefficient 0.03746 indicates a positive relationship between the two groups, with a statistically significant Chi-square value of 11.8599 ($p=0.037^*$).

AFTER REMOVING GLOVES: A similar trend is observed, where 75 practitioners and 236 students reported always washing their hands after glove removal. The correlation coefficient of 0.04744 also suggests a significant difference in practices between students and practitioners (Chi-square = 11.1445, $p=0.025^*$).

USE OF PROCEDURE GLOVES: 66 practitioners and 200 students reported always using gloves during radiographic exposure, but the p-value of 0.633 indicates no significant difference in adherence between the two groups.

USE OF PPE

MASK, SURGICAL CAP, AND MEDICAL COAT: A higher percentage of students (188) reported always using these items compared to practitioners (58), with a significant Chi-square value ($p=0.041^*$). This suggests that students may be more inclined to adhere to PPE guidelines.

USE OF PROTECTIVE OVER-GLOVES: A noteworthy difference is observed in the use of protective over-gloves, where 46 practitioners and 140 students reported consistently using them. The Chi-square value of 18.5273 and p-value of 0.002* indicate a significant positive correlation in favor of students (Figure 1).

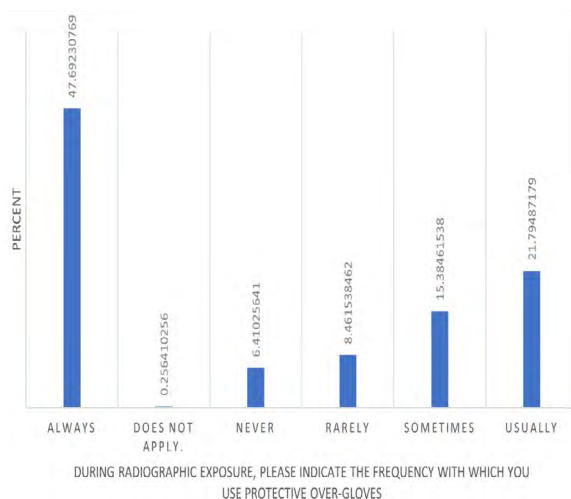


Figure 1. Frequency of using protective over-gloves during radiographic exposure.

STERILIZATION PRACTICES

RADIOGRAPHIC FILM-HOLDING DEVICE: A significant portion of students (195) reported always sterilizing the device, while only 46 practitioners did. The Chi-square value is highly important ($p=0.000^*$), suggesting a strong preference for students to adhere to sterilization protocols (Figure 2).

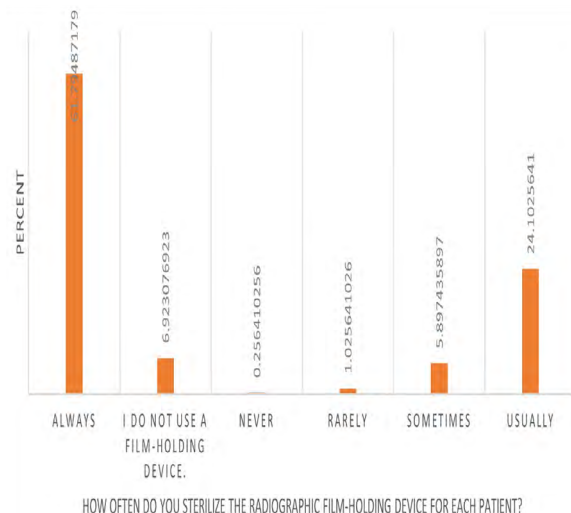


Figure 2. Frequency of sterilizing the radiographic film-holding device for each patient.

PLASTIC BARRIERS FOR INTRAORAL FILMS:

Similarly, students (192) reported higher usage of plastic barriers compared to practitioners (51), with a statistically significant result ($p=0.000^*$).

DISINFECTANT USE: Participants predominantly reported using 70% alcohol as a disinfectant (61.8% of students and 51 practitioners), indicating a common preference. However, the p -value of 0.335 indicates no significant difference in disinfectant use between the two groups.

LOGISTIC REGRESSION ANALYSIS

Binary logistic regression was conducted to determine the likelihood of students versus practitioners demonstrating adequate adherence in different domains (Table 2).

Table 2. Logistic regression results for domain-specific knowledge and adherence.

Domain	OR (95% CI)	p-value
Hand hygiene	0.85 (0.70-1.04)	0.106
PPE use	1.72 (1.40-2.11)	<0.001
Protective over-gloves	0.91 (0.75-1.11)	0.363
Sterilization of devices	1.61 (1.32-1.98)	<0.001
Plastic barriers	1.65 (1.34-2.02)	<0.001

- Students had significantly higher odds of PPE use (OR 1.72), sterilization (OR 1.61), and plastic barrier use (OR 1.65).
- No significant difference was found for hand hygiene ($p=0.106$) or over-glove use ($p=0.363$).

RESPONSE RATE AND MISSING DATA

Of 420 invited participants, 392 completed the questionnaire (response rate=93.3%). Incomplete or invalid responses ($n=28$) were excluded from the analysis. Missing data within valid questionnaires were handled using listwise deletion.

DISCUSSION

The findings of this study provide a thorough grasp of how dental professionals and students in the state comprehend and adhere to infection control procedures in oral radiology. The general adherence to infection control procedures, particularly hand cleanliness, glove use, and equipment sterilization, shows the dentistry community's strengths and areas for improvement.

Our study showed that fewer than half of the participants consistently washed their hands before donning gloves. (46.2%) This suggests that dental professionals must be more conscious of and adhere to hand hygiene guidelines more strictly. While a sizable majority (79.7%) stated that they always wash their hands after removing their gloves, the minority who do not regularly do so present a danger of infectious transmission and cross-contamination.

According to a Cheng HC study on hand hygiene practices in dentistry settings, the overall handwashing compliance rate was 34.7%. When working in oral surgery services, the handwashing compliance rate was greater (92.8%) than in general clinical practice (34.2%) (7). This implies that adherence to hand hygiene measures is significantly influenced by the nature of the work and the training received in these departments. It was also determined that oral surgery services had a better accuracy rate for handwashing (87.5%) than general clinical practice (51.0%). Our finding confirms that training and recent exposure to infection-control teaching can significantly boost adherence among students compared to practitioners.

The study by Vega OG, Janus C, and Laskin DM evaluated the knowledge of dentists and dental specialists regarding proper hand hygiene practices. It concluded that there was no signifi-

cant difference in the level of knowledge between general dentists and specialists (8). Notably, our study stands out because we found students to be significantly more compliant than practitioners. Vega *et al.* only looked at qualified dentists, whereas our study compared students currently getting structured infection-control education with practicing clinicians who might not have had recent training.

Glove use was generally high in our population. However, only a small portion of participants wear gloves infrequently (5.9%) or never (1.3%) points to additional instruction and reinforcement of glove use as a standard infection prevention procedure.

Personal protective equipment (PPE) usage in dental offices increased significantly during the COVID-19 epidemic. Stricter infection control procedures were put in place by dental health-care professionals to lessen the possibility of viral transmission (9) In their study, Lisa M. Casanova *et al.* evaluated the risk of self-contamination after removing PPE for the treatment of Ebola patients. They discovered that self-contamination can happen to even skilled medical professionals, particularly when they use alcohol-based hand rubs for glove hygiene (10).

In our study, participants' adherence to wearing gloves and PPE varied. Even though 63.1% of respondents said they always wear PPE, a sizeable percentage just occasionally (8.7%) or infrequently (3.3%) follow this recommendation. The rate of people who always wore over-gloves was significantly lower, at 47.7%. This finding is consistent with Santos *et al.*, who reported wide variation in adherence to radiology-specific infection control measures across institutions, with protective barriers and over-gloves often being the least-followed recommendations (4). This emphasi-

zes the necessity of focused interventions to increase adherence to PPE use and over-glove procedures to guarantee complete infection prevention.

A sizable percentage of respondents (61.8%) always and usually (24.1%) sterilized their equipment. The fact that some individuals only seldom (5.9%) or infrequently (1.0%) sterilize their devices suggests that strict adherence to sterilization procedures is required. This is essential for reducing the risk of contamination and ensuring patient safety.

Plastic barriers for radiological receptors were consistently employed by most respondents (62.3%), which is a good practice for preserving infection control. Nonetheless, more utilization from the remaining participants is still required. In our study, plastic shielding was also often used (67.2%). Numerous studies stress how crucial it is to correctly handle and use plastic barriers to reduce the danger of contamination in dental radiography. They discovered that incorrect handling and flaws in the barrier envelopes led to contamination, emphasizing the necessity of aseptic procedures and appropriate sealing (11, 12, 13).

According to Nyirenda D. *et al.*, only 10% of study participants washed and disinfected the anatomical marker and lead apron with a disinfectant solution each week, while 92% of participants always covered the X-ray cassette with plastic when evaluating isolated patients (14). Our study found that practitioners were less likely to follow protective covering guidelines, revealing a significant gap that needs to be addressed through targeted continuing education programs.

Most participants in our survey used 70% alcohol in conjunction with other cleaning techniques, indicating that disinfection practices were

generally strong. Nonetheless, the fact that 1.8% of respondents said they did not clean at all suggests that adherence gaps require attention.

Over half of the participants reported wearing over-gloves when handling digital radiography equipment. This suggests that while using digital technology, there is a need for greater knowledge and adherence to infection control procedures. The chance of cross-contamination can be considerably decreased by making sure that all practitioners wear overgloves. Luciana Maria Paes da Silva Ramos Fernandes, Ronald Ordinola Zapata, Izabel Regina Fischer Rubira-Bulleni, and Ana Lúcia Álvares Capelozi reviewed how microbiologic contamination can occur during intraoral radiographic examinations and emphasized the need for efficient protection barriers, including gloves, to ensure a safe environment for patients and professionals (15).

The frequency of cleaning and disinfecting various items, including the patient's chair and X-ray apron, was generally high, with most participants reporting cleaning after every patient. However, the minority who clean less frequently or are unsure of their cleaning practices highlight the need for consistent and regular cleaning protocols. Most participants favored disinfectants such as 70% alcohol, which is a good sign of infection control awareness. Still, our findings highlight that while routine practices are often followed, more specialized infection-control steps in radiology (e.g., film-holder sterilization, use of protective barriers) remain inconsistently applied, in agreement with Gumru et al., who noted cross-contamination risks specific to intraoral imaging procedures (5).

Another goal of the study was to compare infection control procedures between dental practitioners and students. The results imply differences in adherence levels even when both groups show a dedication to infection prevention. Dental students

typically demonstrated greater compliance with hand cleanliness, glove use, and device sterilization than practitioners. This was further confirmed in logistic regression analysis, where students had significantly higher odds of PPE use, sterilization, and plastic barrier application.

Limitations: The findings may not apply universally due to differences in regional regulations. Also, the absence of direct observation of infection control practices can create bias.

Future prospects: The study can be a foundation for developing standardized guidelines to ensure effective infection control practices across dental settings.

CONCLUSION

On the whole, participants showed moderate level of knowledge and adherence to infection-control measures during oral radiology procedures. Dental students were more compliant than practitioners, particularly regarding hand hygiene after glove removal, routine use of PPE, over-glove use, and sterilizing film-holding devices. However, gaps were noted in both groups, especially in hand hygiene before wearing gloves, consistent use of over-gloves, and disinfecting radiographic accessories.

These results emphasize the need for targeted training, reinforcement of student curriculum, and continuing education programs for practitioners to ensure consistent adherence to infection-control protocols in radiographic practice. By strengthening these measures, we can reduce cross-contamination risks and improve patient and provider safety.

STATEMENT OF DATA AVAILABILITY: The data supporting this study's findings are available from the corresponding author upon request. Due to privacy and ethical restrictions, the data are not publicly available.

FINANCIAL SUPPORT AND SPONSORSHIP: Nil.

CONFLICTS OF INTEREST: There are no conflicts of interest.

AUTHOR CONTRIBUTION STATEMENT: Conceptualization and design: S.G. and K.A.; Literature review: P.R. and V.S.; Methodology and validation: S.G. and K.A.; Formal analysis & statistics: P.R. and V.S.; Investigation and data collection: P.R.; Resources: S.G.; Data analysis and interpretation: P.R. and V.S.; Writing-original draft: P.R. and V.S.; Writing-review & editing: S.G. and K.A.; Supervision: S.G.; Project administration: S.G.; Funding acquisition: None

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