

Comparison of Protocol Adherence in Maxillofacial Radiology Centers in Tehran Before and After the COVID-19 Pandemic

Sarvin Soleimanpoor^{1a}, Hamidreza Khalighi^{2b}, Mahkameh Moshfeghi^{3c}, Amirali Momeni^{1a*}

^aDentist, Tehran, Iran.

^bDepartment Oral & Maxillofacial Medicine, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

^cDepartment Oral & Maxillofacial Radiology, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

*Correspondence to Amirali Momeni, Email: dr.amiralimomeni@sbm.ac.ir

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Abstract

Objective(s): The COVID-19 pandemic, caused by SARS-CoV-2, significantly impacted healthcare practices worldwide. Maxillofacial imaging centers were particularly affected due to their close interaction with patients and the use of aerosol-generating procedures. This study aimed to evaluate the changes in personal protective equipment (PPE) use, infection control protocols, and imaging practices before and after the pandemic in maxillofacial imaging centers in Tehran. **Methods:** This cross-sectional study used a before-and-after design to examine infection control and PPE protocol changes in maxillofacial imaging centers. A questionnaire that covered general information, patient triage, staff performance, and health protocols was distributed to 25 imaging centers and completed by the staff. Data was analyzed utilizing McNemar's test to compare the conditions before and after the pandemic. **Results:** The study found a significant increase in the use of PPE among staff and patients following the COVID-19 outbreak. There was a 60% increase in mask usage by staff ($P<0.05$), and 72% of centers required patients to wear masks after the pandemic ($P<0.05$). Changes in ventilation systems and social distancing measures were also noted, with 27% of centers installing new ventilation systems after the pandemic ($P<0.05$). However, the sterilization of imaging equipment remained largely unchanged, with 98% of centers maintaining chemical disinfection practices.

Keywords: COVID-19; Infection Control; Maxillofacial Imaging

Introduction

Coronavirus Disease 2019 (COVID-19), caused by the SARS-CoV-2 virus, was first identified in December 2019 in Wuhan, China. The virus spread quickly, escalating into a global pandemic within a few months. It was transmitted via respiratory droplets from sneezing, coughing, and contact with contaminated surfaces.¹ In the early stages of the outbreak, the rapid transmission of the virus and the lack of vaccines or effective treatments placed tremendous strain on healthcare systems worldwide, significantly affecting health behaviors and infection control protocols in various medical facilities.^{2, 3}

Dental offices and maxillofacial imaging centers faced a higher risk of virus transmission due to their close patient interactions and use of aerosol-generating equipment. Given their need for face-to-face contact and the presence of saliva and blood in these environments, it was essential to implement significant changes to health protocols and personal protective equipment (PPE) usage during the pandemic.^{4, 5}

The World Health Organization (WHO) has established standard protocols for dental radiography to ensure patient safety and minimize radiation exposure. These protocols include guidelines for patient selection, appropriate radiographic techniques, and the implementation of protective measures such as lead aprons and thyroid collars.³ The WHO

has also emphasized the importance of proper training for dental professionals in safely using radiographic equipment and interpreting radiographic images.⁶

During the COVID-19 pandemic, maxillofacial imaging centers were at increased risk due to procedures generating aerosols, such as intraoral radiography.⁷ Aside from prompting changes in work processes and health protocols, the pandemic also highlighted the growing need for remote technologies such as digital imaging and remote consultations.^{7, 8}

In light of the pandemic's significant impact on dental and maxillofacial imaging centers, this study aimed to investigate changes in the use of PPE, imaging procedures, and infection control protocols within these facilities. The findings can enhance health guidelines and improve the preparedness of medical centers for future potential pandemics.

Methods

This cross-sectional study employed a before-and-after design to analyze changes in PPE use and infection control protocols in maxillofacial imaging centers before and after the COVID-19 outbreak. This study selected technicians from various maxillofacial imaging centers across Tehran, Iran as

the study population. These centers were classified according to their geographical locations and patient interactions.

All participants joined the study voluntarily and were informed about its objectives. They were assured that the collected information would be kept confidential, and results would not be reported in a way that would identify any specific center. The study was approved by the Ethics Committee of Shahid Beheshti Dental School on November 23, 2022, with the registration number IR.SBMU.DRC.REC.1401.077.

Initially, a questionnaire was created with five sections: general information about the center, changes in staff performance, patient triage, modifications in imaging procedures, and adherence to health protocols (Supplementary file-1). Subsequently, the content validity of the questionnaire was assessed by experts and staff from the Radiology Department of Shahid Beheshti Dental School. The results were analyzed using the content validity ratio (CVR) and content validity index (CVI). The CVR is a statistic item useful in rejecting or retaining individual items and is internationally recognized as the method for establishing content validity.⁹ The CVI is the mean CVR for all the items included in the final instrument.¹⁰ Based on the experts' feedback, three questions were removed due to their CVR scores falling below the required threshold, which helped ensure the reliability and validity of the questionnaire. After a briefing on the process, the questionnaires were distributed among 25 clinics through an online platform (PorsLine). PorsLine is an online questionnaire software service that can be used to create the required questionnaires and forms. Two staff members from each clinic completed the questionnaires to ensure accuracy, and any discrepancies in their responses were clarified with the clinic manager.

After collecting the questionnaires, the data was initially entered into Excel. To score the relevant sections and conduct statistical tests, the data was then transferred to SPSS version 22.0. Frequency distribution tables were utilized to summarize the data, and the McNemar test was used to compare conditions before and after COVID-19 at a significance level of 0.05.

Results

Among the center managers, 60% were university faculty members, while 40% were individuals without any academic or scientific affiliations. Regarding patient education, only 34% of imaging centers provided written infection control instructions before and after the COVID-19 outbreak. However, 36% of centers ($P<0.001$) implemented written instructions following the onset of the pandemic. Most centers (68%) provided verbal instructions to patients both before and after COVID-19, while 24% initiated verbal explanations after the pandemic ($P<0.05$). Before COVID-19, only 6% of centers mandated the patients to wear masks; however, this

requirement increased to 72% following the pandemic. Additionally, 22% of centers did not require masks for patients before or after COVID-19 ($P<0.05$). Fifty-eight percent of centers did not mandate disposable gloves for patients before or after COVID-19, while 38% implemented glove usage after the pandemic began ($P<0.05$). Furthermore, 74% of centers that did not enforce social distancing before the pandemic required patients to maintain a distance of at least 1.5 meters apart after it started ($P<0.05$).

Regarding staff performance and environmental changes, 60% of centers did not require masks for the staff before COVID-19 and mandated mask usage after the pandemic, while 40% required the staff to wear masks before and after ($P<0.05$). In 92% of centers, staff used disposable gloves consistently before and after COVID-19, with no significant changes observed ($P<0.05$). Additionally, 72% of centers did not require staff to wear shoe covers and gowns at any time, while 26% enforced this requirement after the pandemic ($P<0.05$). Twenty-two percent of centers did not mandate respiratory vaccinations (such as tuberculosis, influenza, or COVID-19) for staff before or after the pandemic. However, 50% of the centers that did not require vaccinations before COVID-19 began enforcing vaccination documentation afterward. Only 28% of the centers required vaccinations before and after the pandemic ($P<0.05$).

Regarding hand hygiene, 74% of center staff received hand hygiene training before and after the pandemic, while 14% had not been trained before or after COVID-19. Only 12% of centers that did not prioritize hand hygiene before the pandemic, began offering training afterward ($P=0.310$). Regarding respiratory hygiene, 24% of centers that lacked high-pressure suction systems or air ventilation systems before COVID-19 installed these systems after the pandemic, while 52% had such systems before and after COVID-19 ($P<0.05$).

Regarding disinfection practices, 8% of centers that did not disinfect imaging equipment before COVID-19, changed their practices afterward, while 90% consistently disinfected their equipment before and after the pandemic ($P=0.500$). For sterilizing film holders using autoclaves, 58% of centers did not perform sterilization at any time, while 38% did sterilize before and after COVID-19. Only 4% of centers that did not sterilize film holders before the pandemic changed their practices afterward ($P<0.05$). Ninety-eight percent of centers disinfected film holders with chemical solutions before and after COVID-19 ($P<0.05$).

In addition, 82% of centers preferred panoramic imaging before and after COVID-19, while 10% of centers that previously preferred periapical imaging switched to panoramic imaging after the pandemic ($P=0.630$). Eighty-eight percent of centers used the parallel imaging technique before and after COVID-19 ($P=1.000$). It was also found that 40% of centers increased their staff count after COVID-19.

Regarding patient triage, 86% of appointments were made in

person before the pandemic, and 14% were made remotely. Following the pandemic, these figures shifted to 80% in-person and 20% remote appointments ($P=0.630$). Additionally, in 80% of cases where remote triage was used before COVID-19, restrictions on the number of person(s) accompanying the patient were imposed afterward ($P<0.05$). Half of the centers did not take respiratory history before or after COVID-19, while 30% began asking for respiratory history after the pandemic. Only 20% consistently took respiratory history before and after ($P=0.250$).

In 82% of centers that did not require gloves, shields, or masks for patients in waiting rooms before COVID-19, regulations were implemented afterward ($P<0.05$). Sixty percent of centers had adequate ventilation systems in waiting rooms before and after the pandemic, 27% installed ventilation systems after COVID-19, and 12% had no ventilation at any time ($P<0.05$).

Regarding social distancing, 42% of centers added physical barriers between seats in waiting rooms after COVID-19, while 58% relied solely on distancing measures ($P<0.05$). Eighty-seven percent of centers did not have an isolated waiting room for suspected COVID-19 patients before or after the pandemic, and 12% created such rooms afterward ($P=0.375$). After COVID-19, 62% of centers stopped performing elective or non-emergency imaging, while 38% continued to offer these services.

Regarding patient exposure, 82% of centers did not use chlorhexidine mouthwash before or after imaging, while 6% used it consistently at both times. Additionally, 12% of centers began using the mouthwash after the pandemic ($P=0.310$). All centers conducted imaging on children both before and after COVID-19.

Discussion

With the global spread of COVID-19, health protocols were designed to protect dentists, healthcare staff, and patients, requiring implementation before, during, and after dental treatments. Given that maxillofacial imaging centers are integral to dental care, especially in emergency procedures, this study aimed to evaluate the differences in adherence to these protocols before and during the COVID-19 pandemic. This study demonstrated that the COVID-19 pandemic led to significant changes in adherence to health protocols and the use of PPE in maxillofacial imaging centers.

As observed in this study, the use of masks and PPE for staff and patients increased significantly after the COVID-19 pandemic. This finding is consistent with the results of similar studies. For example, a study conducted by Turska-Szybka et al. in 2020 showed that 84% of dentists treated patients while adhering to health protocols during the pandemic.¹¹ Additionally, Khanal's study revealed that 23% of dentists refrained from treating non-emergency patients, and 63% only treated emergency cases.¹²

As COVID-19 is a respiratory infection with high transmission rates and the related information constantly evolves, educating patients about infection control and personal protection has become crucial. The results of this study indicated significantly higher rates of infection control instructions after the pandemic outbreak, mainly through verbal explanations. These findings suggest that maxillofacial imaging centers have enhanced patient education considerably following the pandemic.

Research has shown that requiring staff to wear masks reduced the number of COVID-19 cases.^{13, 14} We observed that mask mandates were associated with a statistically significant increase after the pandemic; 60% of centers that did not require staff to wear masks before COVID-19, implemented mask mandates after the pandemic; in contrast, 40% required mask use for staff both before and after ($P<0.05$). This study also showed that following societal norms, more centers enforced mask-wearing for patients after the pandemic ($P<0.05$). Additionally, although a relatively small percentage of centers enforced this rule, gown use for patients increased in some centers after COVID-19. This suggests a need for further education and strict enforcement of health protocols.

The study also found improvements in ventilation and patient distancing in imaging centers. Prior research had underscored the importance of proper ventilation in indoor spaces to minimize virus transmission. For instance, a study by Cabrera-Tasayco et al. highlighted the need for adequate ventilation systems and the elimination of shared items (such as water coolers, magazines, and children's toys) in waiting rooms to help reduce transmission.¹⁵

Regarding sterilizing film holders, 98% of centers disinfected them with chemical agents before and after COVID-19. However, 58% of centers did not use autoclaves for sterilization at any time, while 38% sterilized film holders before and after the pandemic. Although there was no significant difference in practices before and after COVID-19, it can be concluded that most centers continue to favor chemical disinfection.

Various studies have indicated an increased use of panoramic imaging during the pandemic, largely due to the reduced need for intraoral radiography, which carries a higher risk of virus transmission.^{16, 17} MacDonald et al. recommended using extraoral radiography whenever possible to minimize this risk.¹³

The increase in staff count following the COVID-19 outbreak indicates that healthcare centers are working to manage their workforce better and reduce staff density in the workplace. This growth may result from implementing shift scheduling and creating safer work environments to minimize the risk of virus transmission.

Many centers suspended elective imaging procedures after COVID-19, supposedly due to staff fears about virus transmission. The absence of isolated waiting rooms for

suspected cases, both before and during the pandemic, may have influenced this decision. Many centers established mandatory requirements for masks, disposable gloves, and gowns for patients in exposure rooms after the pandemic began.

All centers performed imaging for children both before and after the COVID-19 pandemic. Nonetheless, 90% of the centers did not have separate exposure rooms for children at any time, and only 6% of those centers created them afterward. It is noteworthy that only 4% had these rooms before COVID-19. Given that children could often be asymptomatic carriers of COVID-19 and that mortality rates among children were increased since the pandemic's onset^{18, 19}, imaging centers should have established separate rooms for pediatric patients.

Conclusion

Based on the results of the current study, following the COVID-19 pandemic, maxillofacial imaging centers experienced significant changes in adherence to health protocols and PPE use during and after the COVID-19 pandemic. The use of masks, face shields, gowns, and gloves by patients and staff increased, along with significant adjustments to social distancing and air ventilation practices. This study emphasized the significant impact of the COVID-19 pandemic on medical and health centers, highlighting the necessity for strict health protocols and personal protective equipment (PPE). Maxillofacial imaging centers should continue to adhere to these protocols and utilize appropriate PPE to minimize the risk of any microbial transmission. Additionally, establishing isolated rooms for suspected patients and improving ventilation systems could help reduce transmission risks.

This research can form a basis for creating more comprehensive guidelines to prepare for future potential pandemics.

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Author Contributions: S.S: Conceptualization, Data Collection, Draft Writing; and H.K: Methodology, Supervision, Data Analysis; and M.M: Questionnaire Validation, Review & Editing; and A.M: Correspondence, Final Review, Project Administration; and All authors have read and approved the final version of the manuscript.

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Ethical Approval Code: The study was approved by the Ethics Committee of Shahid Beheshti Dental School on November 23, 2022, with the registration number IR.SBMU.DRC.REC.1401.077

Informed Consent Statement: Participation in this study was entirely voluntary. All participants were informed about the objectives of the study, and consent was obtained prior to questionnaire completion. No personal identifiers were collected, and all data were analyzed anonymously to ensure participant confidentiality.

Using AI: This study did not involve the use of artificial intelligence (AI) in any part of its design, data collection, analysis, or manuscript preparation. All processes, including questionnaire development, data entry, statistical analysis, and writing, were carried out manually by the researchers and operators involved.

Conflict of Interest: The authors declare no conflict of interest.

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COVID-19 Protocol Compliance Questionnaire

Dear Imaging Center Staff,

This questionnaire has been designed to assess the level of compliance with infection control protocols related to COVID-19 in your radiology center. We kindly ask you to help us identify strengths and challenges in protocol adherence by completing this form. No personal information is required, and your identity will remain anonymous. All data will be kept confidential.

We sincerely appreciate your cooperation.

Section 1: General Information about the Center

1. Duration of center activity:
2. Gender of the center manager: Male Female
3. Municipality district:
4. Is the center manager a university faculty member? Yes No

Section 2: Patient Education

Question	Before COVID-19	After COVID-19
5. Is there a written infection control guideline available?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
6. Are verbal infection control instructions provided?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
7. Are patients educated on hygiene protocols (e.g., hand disinfection, mask use, etc.)?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
8. Is mask-wearing mandatory in the waiting area?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
9. Is wearing a gown mandatory?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
10. Is wearing shoe covers mandatory?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
11. Are gloves provided during imaging?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
12. Do patients maintain 1.5 m distance before sitting?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No

Section 3: Staff Performance and Environmental Changes

(Questions 13 to 30 follow a similar yes/no before/after format, translated accordingly.)

Examples:

Question	Before COVID-19	After COVID-19
13. Are there posters or brochures related to hand hygiene in the center?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
14. Do staff use masks?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
15. Do staff use face shields or protective glasses?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
16. Do staff use gloves?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
17. Do staff use gowns and shoe covers?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
18. Are staff vaccinated for respiratory infections?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
19. Are facilities like sinks, soap, and tissues available for hand hygiene?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
20. Have staff received training on hand hygiene (e.g., disinfection methods)?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
21. Is there a protocol for respiratory hygiene (ventilation, high-pressure suction, etc.)?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
22. Are miscellaneous items like newspapers, toys, or water dispensers available?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
23. Is there a protocol for disposing used tissues and waste?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
24. Are imaging devices regularly disinfected?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
25. Are dental tools regularly sterilized using autoclave after each patient?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
26. Are dental tools regularly disinfected using chemical solutions?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
27. Is PA (periapical) imaging the most frequently prescribed?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
28. Do most dentists prescribe panoramic imaging?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
29. Is the most common intraoral PA technique parallel or bisecting angle?		
30. Has the number of staff increased after COVID-19? <input type="checkbox"/> Yes <input type="checkbox"/> No		

Section 4: Patient Triage

| 31. Appointment method before COVID-19: | In-person Remote |

| 32. Appointment method after COVID-19: | In-person Remote |

If the triage is in remote method, answer questions 33 to 34. If it is in person, answer questions 35 to 41.

Question	Before COVID-19	After COVID-19
33. Is there an emphasis on limiting the number of accompanying persons? If yes, how many?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
34. Is the patient's health status, particularly respiratory diseases, recorded remotely?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
35. Are accompanying persons allowed to enter the clinic?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
36. Is the patient's health status, particularly respiratory diseases, recorded in person? If yes, is service denied in special cases?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No

Question	Before COVID-19	After COVID-19
37. Are protocols like mask, shield, and glove use enforced in the waiting area?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
38. Is proper ventilation and room temperature provided for better breathing?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
39. Are physical barriers used to ensure required distancing?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
40. Is there an isolated room to separate suspected infected patients?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
41. Are elective imaging procedures performed?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No

Section 5: Exposure Process

Question	Before COVID-19	After COVID-19
42. Is chlorhexidine mouthwash used before imaging?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
43. Are children imaged at the center?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
44. Are there air ventilation systems in the exposure rooms?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
45. Are there isolated exposure rooms for children?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No