

Digital prosthetic workflow during COVID-19 pandemic to limit infection risk in dental practice

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Keywords: COVID-19, dental impression, dentistry, digital workflow, intraoral scanner, Sars-CoV-2

1 | INTRODUCTION

A novel human coronavirus (SARS-CoV-2) causing a severe acute respiratory syndrome, coronavirus disease 2019 (COVID-19), was reported in Wuhan, China, at the end of 2019 (Khan, Ali, Siddique, & Nabi, 2020; Wang, Horby, Hayden, & Gao, 2020). The infection has an estimated incubation period of 1–14 days, and its clinical manifestations and symptoms include cough, fever, and shortness of breath (Zhuet al., 2020).

Health professionals are extremely exposed to COVID-19 infection, with dental health professionals (dentists, hygienists, assistants, and technicians) likely at risk due to the close contact with patients and the exposure to biological fluids and aerosol/droplets production during dental procedures (Izzetti, Nisi, Gabriele, & Graziani, 2020; Peng et al., 2020).

Furthermore, in absence of adequate precautions, the dental clinic could potentially expose patients to contamination, especially the most vulnerable subjects (elderly, diabetic, and the immunocompromised patients) (Meng, Hua, & Bian, 2020; Peng et al., 2020). For these reasons, during the pandemic, the Italian Ministry of Health has recommended dentists to limit dental activities to the emergencies and treatments that cannot be postponed (Izzetti et al., 2020). Prosthodontics is usually considered a deferrable treatment; however, there might be some exceptions: pre-existent broken fixed bridge to replace, endodontically treated tooth to cover with crown or inlay/onlay, endocanal post to fabricate or tooth- or implant-supported prostheses in the esthetic sector. Therefore, it might be necessary to take a dental impression during the COVID-19 pandemic.

Based on recent reviews (Ahlholm, Sipilä, Vallittu, Jakonen, & Kotiranta, 2018; Chochlidakis et al., 2016) comparable results to conventional analogic impressions can be obtained for fixed prosthodontics (FPD) using an intraoral scanner, especially for single crowns or short FPDs, saving time at the dental chair and reducing costs (Barengi, Barengi, Cadeo, & Di Blasio, 2019; Joda, Ferrari, Gallucci, Wittneben, & Brägger, 2017).

Computer-aided design/computer-aided manufacturing (CAD/CAM) technology has become extremely popular among dental technicians: It significantly reduces costs and working time and requires fewer steps, and the sources of error are diminished compared to conventional workflow (Chochlidakis et al., 2016; Joda et al., 2017). Furthermore, another important aspect is that the digital prosthetic workflow has several benefits in terms of infection prevention, without requiring impression disinfection (Barengi et al., 2019).

The aim of this study was to report our experience in not deferrable prosthodontics cases treated during the COVID-19 pandemic and to highlight the advantages of a fully digital protocol to overcome and to limit the possible infection risk for dental professionals and patients.

2 | CASES TREATED

During "phase I" of the COVID-19 pandemic (March 10–May 4), we delivered bridges or single crowns to 12 patients, either males (5) or females (7), with a mean age of 62.66 ± 12.58 years; a considerable reduction from the number of patients treated in the same period of 2019 (75 patients). Only patients with broken tooth/implant-supported provisional bridges/crowns or rehabilitations in the esthetic sector were admitted to prosthetic treatment and

received definitive restorations. A significant reduction in working time (70 ± 18.97 vs 110 ± 10.9 min, respectively) and number of appointments (2.33 ± 0.51 vs 2.83 ± 0.75 appointments, respectively) verified when a fully digital workflow was implemented compared to the conventional workflow. Our complete experience is reported in Table 1.

3 | DISCUSSION

Disinfection of dental impressions can be realized via immersion or spray: Polyether materials and irreversible hydrocolloids have a higher risk of distortion after immersion, which is also time-consuming and expensive, with the necessity of freshly prepare and immediately discharge disinfectants (Chidambaranathan & Balasubramaniam, 2019). Several studies have shown that there is high level of contamination for dental impressions arriving in a dental laboratory (Powell, Runnells, Saxon, & Whisenant, 1990; Sofou, Larsen, Fiehn, & Owall, 2002). Based on the results of a recent critical review (Vázquez-Rodríguez et al., 2018), disinfection protocols are not adequately applied and sub-standard infection control practices are implemented in dental laboratories. During the COVID-19 pandemic, dentists should wear personal protection equipment (PPE) to protect eyes, and oral and nasal mucosa when treating patients and all surfaces of the dental clinic should be carefully disinfected afterward, avoiding the use of handpieces/ultrasonic instruments to limit the production of aerosol/droplets (Meng et al., 2020; Peng et al., 2020). However, even adopting all these precautionary measures, the conventional prosthetic workflow involves several steps and procedures, which may lead to cross infection and viral contamination inside and outside the dental office (Figure 1a). Biological fluids of patients (saliva or blood) can be found in dental impressions and serve as a source of contamination among dental

professionals (Figure 2) (Jakubovics, Greenwood, & Meechan, 2014). In addition, a certain amount of time is usually required for dental impressions to reach dental laboratories: In the meantime, viruses can survive and professionals involved are extremely susceptible of cross contamination (Figure 1a) (Barengi et al., 2019; Barker, Soro, Dymock, Sandy, & Ireland, 2014). At room temperature, SARS-CoV-2 has been reported to remain infectious in the surfaces from 2 hr up to 9 days (Peng et al., 2020). A recent article evaluated its stability on various surfaces: Based on their results, the longest viability was on stainless steel and plastic, with an estimated median half-life of approximately 5.6 hr on stainless steel and 6.8 hr on plastic (van Doremalen et al., 2020). Stock impression trays most commonly used are made by these two materials (Sivaramakrishnan, Alsobaiei, & Sridharan, 2020), and an inadequate cleaning and disinfection might help viral contamination among dental professionals and patients (Figure 2) (Barengi et al., 2019). Furthermore, saliva and/or blood of patients, droplets, and aerosols containing SARS-CoV-2 generated from an infected individual can contaminate dental impressions and if not adequately disinfected can be transmitted to stone models (Peng et al., 2020).

As for digital impressions, the scanner tip is inserted in patient's mouth and can be contaminated with saliva and droplets. Disinfection protocols for scanner tips depend mostly on manufacturers' recommendations: Alcohol-based disinfectants prevent mirror damage and are usually applied for several minutes before the sterilization process (Barengi et al., 2019; Gallardo et al., 2018; Sivaramakrishnan et al., 2020).

In the fully digital workflow, the Standard Triangle Language format (STL) file recorded by the intraoral scanner is received in real time by the dental technician, and the prosthetic restoration is designed and then manufactured in closed automatic conditions using the CAD/CAM technology, with the possibility of producing definitive prosthetic restorations with limited human intervention

TABLE 1 Patients treated during the phase I of the SARS-CoV-2 pandemic (March 10–May 4) for fixed prosthodontics

	Gender	Age	Intervention	Time impression (min)	Total time (min)	Number of appointments
Analogic workflow	F	62	Single crown	25	100	2
	F	47	Implant bridge	45	120	3
	M	49	Implant crown	35	100	2
	M	56	Bridge	45	120	4
	F	67	Implant crown	35	120	3
	M	76	Single crown	25	100	3
Digital workflow	M	79	Bridge	10	90	3
	F	81	Bridge	10	90	3
	F	73	Implant bridge	10	60	2
	M	61	Single crown	7	70	2
	F	56	Single crown	7	70	2
	F	45	Implant crown	10	40	2

Note: All patients treated with a fully digital workflow received monolithic zirconia restorations, and subjects in the analogic workflow group were rehabilitated with zirconia-ceramic restorations.

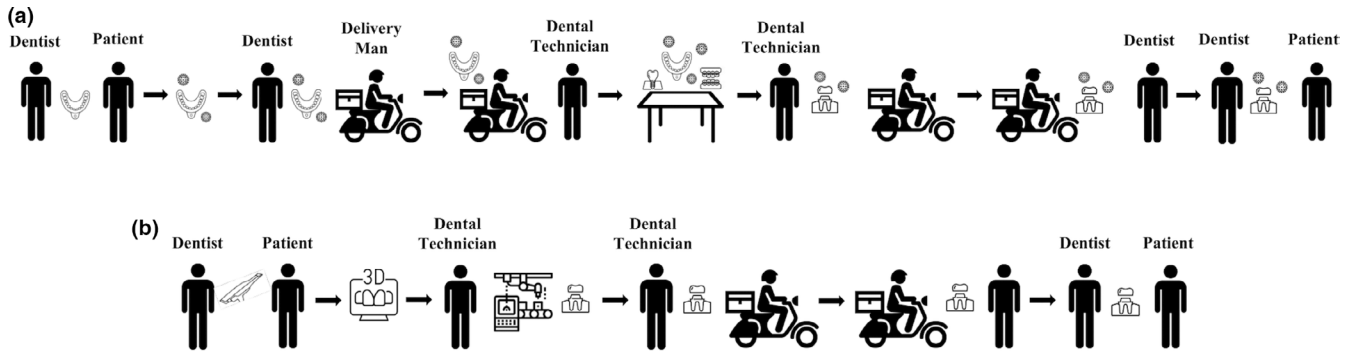


FIGURE 1 (a) Conventional prosthetic workflow: The dentist takes the impression from a potentially infectious patient, the impression might be not adequately disinfected, and the delivery man transports it to the dental laboratory. In the meantime, the virus can survive in the humid ambient; once at the dental laboratory the infected impression can contaminate the working surfaces, instruments, other prosthetic restorations/stone models, and the technician. Then, the technician realizes the prosthetic restoration, which is transported again by the delivery man to the dentist and delivered to patient. These steps might be multiple, and contamination can verify also through human contacts (dentist–patient–delivery man–technician). (b) Digital prosthetic workflow: The dentist takes the digital impression from a potentially infectious patient, and the STL file is received by the laboratory in real time and with no human contact. The CAD/CAM technology, with no infection risk, realizes the prosthetic restoration, which is transported by the delivery man to the dentist and delivered to the patient

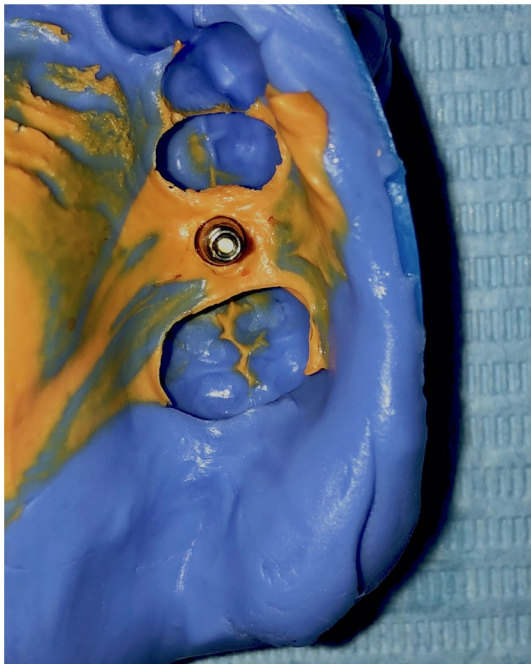


FIGURE 2 Particular of a conventional impression of a dental implant taken with polyvinyl siloxane. Traces of blood are appreciable around the impression coping

(Figure 1b). With a fully digital approach, the infection risk is just limited to the direct contact in the dental office with the patient and contamination can be prevented by the use of PPE, and surface disinfection and sterilization of the scanner tips (Figure 1b). The digital workflow reduces the steps and working time compared to analogic workflow, and, therefore, the possible infection risk: There are no physical impressions or materials/instruments to disinfect, no transportation is required, and the number of appointments is decreased (Figure 1a,b). Based on the authors' opinion, whenever possible, a

fully digital approach should be implemented during the COVID-19 pandemic to limit infection risk in prosthodontics.

ACKNOWLEDGEMENTS

The authors do not have any financial interest in the companies whose materials are included in this article.

AUTHOR CONTRIBUTIONS

Piero Papi: Conceptualization, methodology, writing – original draft; writing – review & editing. **Bianca Di Murro:** Conceptualization; data curation; writing – review & editing. **Diego Penna:** Data curation; resources. **Giorgio Pompa:** Supervision; validation.

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How to cite this article: Papi P, Di Murro B, Penna D, Pompa G. Digital prosthetic workflow during COVID-19 pandemic to limit infection risk in dental practice. *Oral Dis*. 2020;00:1–4. <https://doi.org/10.1111/odi.13442>