Concise Review

COVID-19 Dentistry-Related Aspects: A Literature Overview

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A B S T R A C T

A new coronavirus (Sars-CoV-2) was detected in China at the end of 2019 and has since caused a worldwide pandemic. This virus is responsible for an acute respiratory syndrome (COVID-19), distinguished by a potentially lethal interstitial bilateral pneumonia. Because Sars-CoV-2 is highly infective through airborne contamination, the high infection risk in the dental environment is a serious problem for both professional practitioners and patients. This literature overview provides a description of the clinical aspects of COVID-19 and its transmission, while supplying valuable information regarding protection and prevention measures.

Introduction

At the end of 2019, the first cases of a pulmonary disease of unknown aetiology were detected in Wuhan City, China. In the following months, this new pathogen spread throughout Europe and then worldwide; in March 2020, the World Health Organization (WHO) officially declared a pandemic alert.

This new virus, highly infective especially through airborne transmission, is responsible for an acute respiratory syndrome, distinguished by an often asymptomatic, but potentially lethal, interstitial bilateral pneumonia.[1] This virus, initially named 2019-nCoV and subsequently renamed Sars-CoV-2, belongs to the Coronoviridae family, along with the Middle East respiratory syndrome (MERS-CoV) and the severe acute respiratory syndrome (SARS-CoV) viruses.[2] The most updated epidemiological and genetic studies performed on infected Chinese patients revealed that this pandemic originated from a zoonosis, after a single transmission event between an animal and a human, followed by subsequent, rapid interhuman diffusion.[1,3]

Sars-CoV-2 expresses membrane proteins that permit adhesion between it and specific receptors expressed on the surface of host tissue cells.[4] The most common receptor involved in the virus–cell interaction is angiotensin-converting enzyme 2 (ACE-2), which is present at high concentrations in lungs, myocardial cells and kidney, as well as on oral mucosa (especially of the salivary glands and tongue).[5,6] These structures have been considered as early targets of Sars-CoV-2, with infection causing a disease in humans known as Corona Virus Disease 19 (COVID-19).[7]

The main infection pathways of Sars-CoV-2 are air and direct contact.[1] Airborne infection occurs through droplets released by coughing, sneezing, exhalation or speech;[1,8] direct-contact infection occurs through contact with contaminated surfaces and subsequent touching of the eyes, nose or mouth[8] (Figure 1). Saliva also plays a crucial role in the spread of infection, through both airborne and direct-contact pathways.[1]

The incubation period of Sars-CoV-2 varies between 3 and 14 days; however, a 24-day incubation period has also been reported.[9] In most instances, the infection brought on by this new coronavirus is asymptomatic or causes few symptoms.[2] Infected patients mainly exhibit night fever, dry cough, sore throat and asthenia; patients with more severe disease can exhibit dyspnea. The most severe symptoms occur in 15%–25% of infected patients, with a relevant impairment of respiratory function that leads to hospitalisation and assisted ventilation.[2] From a clinical perspective, this infection presents as a bilateral interstitial pneumonia, detected radiographically as bilateral ground-glass opacity.[10,11]

COVID-19 diagnosis is based on clinical symptoms (e.g., asthenia, dyspnea, headache and hyperpyrexia) and

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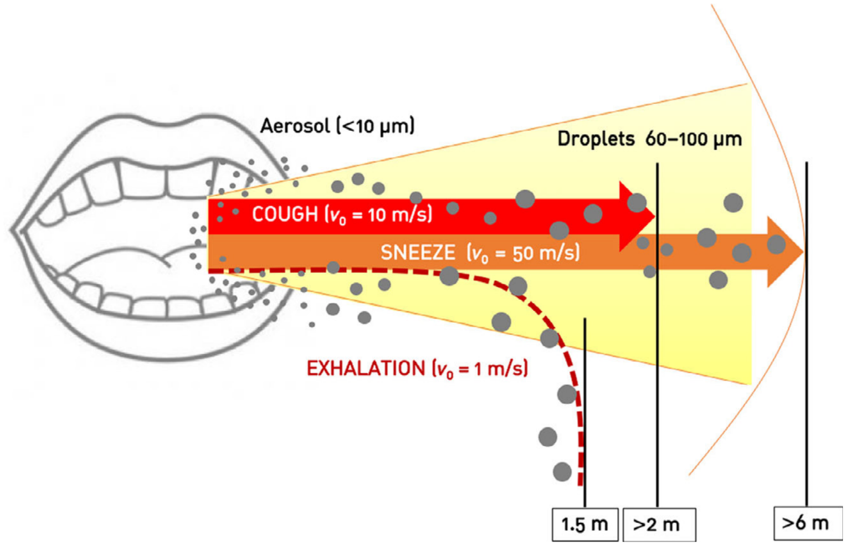

Fig. 1 – Exhalation distances of aerosol microparticles and large droplets. (Original picture with data taken from Xie et al.[36])

epidemiological aspects, particularly involving patients who had previous contact with potentially infected individuals or who travelled through/resided in areas with high concentrations of infected people in the 2 weeks prior to symptom onset.[9]

Recently, a sudden loss of smell (anosmia) and/or taste (ageusia) has been encountered in many Sars-CoV-2-positive patients. Anosmia has been reportedly observed in most Sars-CoV-2-positive German, Swiss and Italian patients; data from Korea suggest that 30% of Sars-CoV-2-positive patients exhibited anosmia as the primary presenting symptom.[12] A high-resolution chest computed tomography scan can show bilateral impairment of lung parenchyma.[13] Biomolecular diagnosis is performed through reverse transcription–polymerase chain reaction (RT-PCR) of samples taken from the upper airways; thus far, this procedure is the gold standard for correctly diagnosing Sars-CoV-2-positivity.[3]

No vaccine is yet available; infected patients are mostly treated with assisted ventilation, oxygen administration (2–15 L/min) and fluid maintenance.[14] Promising results have been reported concerning the development of recombinant monoclonal antibodies for a specific viral antigen, as previously tested on patients with SARS-CoV.[15]

This literature overview focuses on publications regarding this new coronavirus and supplies valuable indications to dental professionals concerning protective and preventive measures that can be adopted.

Methods

PubMed, Embase, Scopus, Web of Science and Cochrane databases were used to identify publications on COVID-19 and COVID-19 dentistry-related aspects, which had been published from the beginning of January 2020 to the end of April 2020. The terms used for the identification of keywords were: COVID-19, 2019-nCov, Sars-CoV-2, COVID-19 transmission, Coronavirus pneumonia, Coronavirus infection, Severe acute respiratory syndrome, Atmospheric contamination, Droplets, Aerosol, PPE/DPI, COVID-19 guidelines, Airborne contamination, Masks and respirators, and COVID-19 dental-related aspects. The inclusion criteria used for screening were papers written in the English language or in the Italian language with an English abstract, which reported on COVID-19 and dentistry-related aspects of COVID-19. The exclusion criteria were: papers in a language other than English or Italian with no English abstract; and studies not reported in the above-mentioned databases. Studies were first screened according to titles and abstracts and examined by two reviewers (V.C. and D.B.); studies that fulfilled the inclusion criteria were selected and their full texts were obtained. The contents were analysed and results were extracted if the papers provided original data regarding Sars-CoV-2. Citations in each article selected during the main search were reviewed for potential relevance.

Results

Sars-CoV-2 transmission pathways in dentistry

Dentists, dental hygienists, dental assistants and patients have always been at high risk of cross infections because of their exposure to pathogenic microorganisms and viruses derived from the oral cavity and airways.[16,17] These groups of professionals face daily risks of contagion and infection transmission because the dental environment typically involves dangerously high levels of microbes[18] as a result of close contact with the patient's oral cavity and the presence of bacteria and viruses in the aerosols created by dental instrumentation.[1,16]

A study performed on a mannequin fitted with phantom jaws, and seated on a dental chair, showed that the highest levels of aerosol contaminants can be found within 60 cm from the patient's head, mainly on the right arm of the dentist, on their mask, and around their nose and eyes. Moreover, the aerosol generated by an ultrasonic device can remain suspended in the air for 30 minutes after the procedure.[19] Therefore, dental procedures can be considered as one of the most probable causes of Sars-CoV-2 infection because such procedures require close proximity to the patient's mouth, possess a risk of contact with saliva, blood and other biological fluids and involve the use of instrumentation that creates large aerosols.[4,19,20]

An *in vitro* study showed that Sars-CoV-2 maintained viability in the air for at least 3 hours and that its viability half-life was nearly 1 hour.[21] Moreover Sars-CoV-2 demonstrates persistent adherence, for a maximum of 9 days, to various surfaces;[1,21] therefore, all surfaces and instruments in a dental clinic should be considered as potential sources of virus transmission because infected droplets from saliva or aerosols could land on any exposed surface.[16,19,22]

Protection mechanisms to avoid infection with COVID-19 in the dental environment

Although it remains unclear which devices are most effective for protection against Sars-CoV-2 infection, all dental patients should be considered as potentially infected.[4] Therefore, the use of Personal Protective Equipment (PPE), such as disposable waterproof scrubs and bonnets, gloves, eyewear protection, face shields, disposable shoe-covers and masks, is highly recommended.[1,23]

Airway protection

Thus far, many doubts remain regarding the type of mask that best protects against COVID-19. Different types of mask have been developed in recent decades; each mask offers a different degree of protection. Surgical masks were conceived with a one-way protection design – to capture bodily fluids leaving the wearer – thus protecting the patient from the risk of contamination by healthcare personnel.[17,24] However, a study performed on mannequin heads showed that surgical masks were also able to provide a filtration effect for the operator, in that they filtered an artificial aerosol made of water and sodium bicarbonate. Two different types of surgical masks – rectangular and shell-shaped – were tested; these showed filtering efficiencies of 92% and 96%, respectively.[24]

In dentistry, the most indicated PPE for airway protection is the Filtering Face-piece (FFP) mask, which can also block virus particles. FFP masks are designed to protect the wearer and are divided into the following different categories based on their filtration efficiency towards powders ≥0.3 μm in diameter: FFP1 (80% minimal total filtration efficiency); FFP2 (94% minimal total filtration efficiency); and FFP3 (99% minimal total filtration efficiency).[17,25] These FFP scores are determined in accordance with EN standard 149:2001 and EN 143, maintained by the European Committee for Standardisation. By contrast, US standards are determined by the National Institute for Occupational Safety and Health (NIOSH), which classifies oral respirators as N95 (95% minimal total filtration efficiency), N99 (99% minimal total filtration efficiency) and N100 (99.97% minimal total filtration efficiency). Comparing European and US classifications, an FFP2 respirator corresponds to an N95 mask, while an FFP3 respirator corresponds to an N99 mask (Table 1).

Table 1 – Respirator filter capacity.

Respirator standard	Filter capacity* (%)
FFP1	At least 80
FFP2	At least 94
N95	At least 95
FFP3 and N99	At least 99
N100	At least 99.97

FFP, Filtering Face-piece.

* Filter capacity is defined as the percentage of all particles ≥0.3 μm in diameter that are removed through the filter.

Because air droplet COVID-19 particles are estimated to be 0.06–0.14 μm in diameter,[26] the most efficient masks are presumed to be FFP2/N95, FFP3/N99 and N100. Surgical masks, however, remain valid devices for all procedures that do not create an aerosol.

In addition to the filtration efficacy, facepieces can be further distinguished as valved or non-valved respirators. Valved respirators facilitate air exhalation, leading to less moisture buildup inside the mask; thus, they can filter the entering air, but do not filter the wearer's exhaled air. Non-valved respirators provide good two-way protection by filtering both inflow and outflow of air.[25,27]

FFP3/N99 and N100 facepieces without valves seem to be the devices primarily indicated to guarantee the highest level of protection for both operator and patient, but it is quite challenging to achieve normal air exhalation when these facepieces are used for an extended period of time.[23] In dental procedures, the mask should be considered as disposable and the mean surgical period does not exceed 2 hours; therefore, it is suggested to use a mask with the highest filtration efficacy without a valve, or a valved mask covered by a surgical mask.

Eye protection

In the dental field, eye protection has been consistently indicated to minimise contact of the eyes with mechanical (e.g., slivers and foreign bodies), chemical (e.g., acids and disinfectants) and biological (e.g., saliva, blood, oral fluids) agents.[18] The ocular pathway is known to be one of the most frequent routes of infection with Sars-CoV-2[1]. Eyewear with enveloping frames should be used, and should have wide lenses to cover the face as much as possible. Alternatively, plastic shields may be preferred to glasses because of their greater capacity to protect the face from aerosol droplets. These shields can be worn directly on the forehead or can be included in the surgical mask.[17] From a practical point of view, the use of a shield is compatible with wearing glasses or magnification loupes; it is much more difficult to achieve proper eye protection while using a microscope.

Mechanisms to prevent spread of COVID-19 in the dental environment

During the pandemic, updated local guidelines have suggested avoidance of dental treatments, except for patients with emergencies. Each dental professional must understand the transmission pathways of Sars-CoV-2 and must perform all essential procedures in a manner that prevents the spread of infection. All patients should be regarded as potentially infected because only symptomatic individuals exhibit fever and breathing symptoms. As a general rule, patients affected by COVID-19 with a body temperature of >37.5°C (99.5°F) cannot be treated in a dental clinic, and should be confined to their home or hospitalised if they exhibit severe symptoms.

Medical history

A triage area is mandatory for initial evaluation of patients, and this area should be set up in such a way that close contact between individual patients and between patients and healthcare personnel is avoided.[4] Preliminary evaluation of patients should consist of body temperature measurement and a brief survey to investigate possible fever, respiratory issues, cough or dyspnea in the past 14 days, as well as contact with individuals who could have been potentially infected.[1]

Patients answering 'yes' to any of the survey questions and who have a body temperature of >37.5°C (99.5°F) should be confined to their home or hospitalised.[1] Patients answering 'yes' to any of the survey questions to the survey and who have a body temperature of <37.5°C (99.5°F) should not be treated for at least 14 days. Patients who have recovered from COVID-19 can be treated 30 days after symptom remission.[4] Patients answering 'no' to the survey questions and who have a body temperature of <37.5°C (99.5°F) can be treated, but procedures that cause aerosol production should be avoided.

Environmental disinfection

Each potentially contaminated surface should be cleaned and then disinfected with hydro-alcoholic disinfectants containing an alcohol concentration of >60%.[1,4,28] A recent review of 22 selected studies evaluated the persistence of human coronavirus on various surfaces and the effects of multiple disinfectant agents on virus inactivation. This review revealed that coronaviruses can persist on plastic, glass and metal surfaces and remain infective for a maximum of 9 days, with a mean infective period of 4–5 days. The authors found that coronavirus could be effectively eliminated in 1 minute when the surfaces were disinfected with 62%–71% ethanol, 0.5% hydrogen peroxide or 0.1% sodium hypochlorite.[22]

More recently, the Sars-CoV-2 survival rate was studied in aerosols, as well as on copper, cardboard, stainless steel and plastic. Sars-CoV-2 was viable in aerosols, with a progressive reduction of its infectious titre within the first 3 hours and a median half-life of approximately 1.1 hours.[21] Moreover, Sars-CoV-2 appeared to be more stable on plastic and stainless steel than on cardboard or copper; the following differences were found regarding the duration before Sars-CoV-2 became inactive: 72 hours for plastic, 48 hours for stainless steel, 24 hours for cardboard and 4 hours for copper[21] (Table 2). Thus, for environmental disinfection, it may be useful to place a dispenser containing an alcoholic gel (with an alcohol concentration of 60%–85%) in the waiting room, for hand cleansing.

Table 2 – Duration of Sars-CoV-2 viability on different surfaces.[21]

Surface	Half-life (hours)	Viability (hours)
Plastic	6.8	72
Stainless steel	5.6	48
Copper	0.8	4
Cardboard	3.6	24

Antimicrobial agents

A valid method to reduce the microbial load in the oral cavity is rinsing before dental procedures. There remains controversy regarding the effectiveness of chlorhexidine against coronavirus.[1,29] Because Sars-CoV-2 is sensitive to oxidation, mouthrinses containing 1% hydrogen peroxide or 0.2% povidone-iodine have been proposed.[1]

Hand hygiene

Hand hygiene is considered the most important preventive measure to reduce the risk of transmission of microorganisms between dentists and patients.[4] Soap and cleansers must be rubbed extensively on both hands, until the appearance of abundant foam. This foam has been shown to dissolve the lipid sheath around the viruses, causing dispersion and decomposition of viral molecules. This action is mediated by the surfactant agents in soaps and cleansers, which can enter the virus lipid membrane through hydrophobic interactions, eventually causing it to lyse.[30] At concentrations greater than 60%-65%, alcohol can dissolve fatty molecules of the external lipid layer of the virus, which leads to disruption of the virus particle; therefore, friction with an alcoholic hand sanitiser is suggested after handwashing.

Minimally invasive procedures

When possible, it is recommended to avoid dental procedures that could cause cough and regurgitation. Orthopantomography (OPG) or cone beam computed tomography (CBCT) are preferred; periapical X-rays should be avoided because they could provoke hypersalivation, coughing or vomiting.[4]

Rubber dam

When handpieces or ultrasonic devices must be used, the use of a rubber dam is indicated as this significantly reduces the amount of aerosol containing saliva and/or blood, providing a 70% reduction of droplets around the surgical field.[31] When isolation using a rubber dam is not possible, manual instrumentation is preferred over high-speed handpieces.[1]

High-speed saliva ejectors

Considerable reduction of droplet spread during dental procedures can be achieved using either high-speed saliva ejectors or surgical ejectors, and the use of such devices is therefore highly recommended.[31] Simultaneous assembly of two ejectors (e.g., a high-speed ejector and a high-volume evacuator) may also be useful.

Anti-retraction high-speed handpieces

Handpieces generally used in dentistry can draw and then expel biological fluids and contaminants that can become deposited on the patient or the dentist, leading to cross infection.[1,32] Because it has been shown that anti-retraction handpieces effectively reduce the return of bacteria and viruses into the tubing system, the use of handpieces without an anti-retraction system should be avoided during the COVID-19 pandemic.[16,28]

Dental environment sanitation

Although there is a lack of information concerning environmental sanitation related to coronaviruses, some options are always useful for reducing bacterial and viral loads in dental clinics. Common sense-based guidelines suggest an adequate air change after each dental procedure by opening the windows in surgical rooms and in the waiting room. Safe distances must be maintained between patients in the waiting room.

In the early 1990s, the air quality in a dental clinic was shown to become extremely polluted by aerial microbiota after the most common dental procedures.[16] When no aerosol is created, most Sars-CoV-2 droplets precipitate and deposit on surfaces. When handpieces or ultrasonic devices are used, the aerosol generated can transmit the virus into the air where it can persist, viable, for more than 3 hours.[21]

Currently, there is no evidence regarding sanitation devices that are especifically effective against Sars-CoV-2. The following air sanitation systems were developed in the past and are commonly used in medical settings.

Air depuration systems have been developed to filter and recirculate the air of surgical rooms and medical and health clinics. Air is drawn through different filters: the first stops bacteria and larger droplets; the second reduces gas components; and the third reduces the numbers of the smallest droplet particles and the smallest microorganisms. These systems can filter droplet particles smaller than 0.01–0.3 μm, with a filtration efficiency of 85%–99%.[16,33]

Ozone is a natural gas, and one of the most effective systems for environmental sanitation. It provides highly reactive free radicals that can oxidise bacteria, viruses and organic and inorganic compounds, thereby effecting bactericidal action towards air contaminants. Because ozone is heavier than oxygen, it precipitates on tissues and disinfects both air and surfaces.[34]

Germicidal ultraviolet (UV) radiation also represents a valid sterilisation option: UV light can damage microbial DNA and RNA, thus preventing reproduction of microbes and reducing the harmful effects of infectious organisms. These UV lights can be installed with a filtration apparatus and used in water- and air-circulation systems to eliminate powders, bacteria and viruses.[35]

Conclusions

This literature overview was intended to collect all relevant published data in the dental field since the identification of the new coronavirus, Sars-CoV-2. It aimed to supply practical information to dental professionals, through analyses of the indications for contamination protection and prevention. However, since this literature search, researchers and scientists may have found and presented new strategies, products and technologies that are more effective against COVID-19.

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Conflict of interests

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