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COVID-19: Dentistry related aspects

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Abstract:

The coronavirus disease 2019 (COVID-19) is a highly contagious transmittable disease caused by a recently discovered coronavirus, SARS-CoV-2. The COVID-19 is associated with a global "pandemic" health situation. In humans, the effects of SARS-CoV-2 range from flu (influenza) like symptoms to severe respiratory tract infections and sometimes death. Some oral manifestations associated with this virus have also been reported. This literature overview provides a description of pathophysiology, the clinical aspects of COVID-19 and transmission. Because SARS-CoV-2 is highly infective through airborne contamination, dental professionals play great roles in the transmission of this virus in dental environment. In this review, we also discussed various preventive and control measures during dental practice to combat COVID-19 effectively. Furthermore, we described and highlighted the potential of tele dentistry as a new approach during the COVID-19 crisis.

Key words: *COVID-19, Coronavirus, dentistry, SARS-CoV-2, dental environment; Personal protective equipment, tele dentistry.*

Background:

In 1968, a Nature publication by Almeida et al. first described a newly discovered single-stranded RNA virus with a diameter of 120 nanometers [1]. They decided to name this new group of viruses "corona viruses" due to their appearance under the electron microscope with their distinguishing fringe of projections on the outer surface of the virus which reminded the scientist of solar corona. Coronaviruses are prone to mutation and recombination, and therefore, around 40 different variations of coronaviruses have been recognized mostly infecting human and non-human mammals and birds [2].
Coronaviruses are a large family of viruses that usually cause mild to moderate upper-respiratory tract illnesses, like the common cold. However, three new coronaviruses have emerged from animal reservoirs over the past two decades and caused serious and widespread illness and death. Those viruses jump to humans— called a spillover event—and can cause more serious, even fatal, disease. The coronavirus (SARS-CoV) emerged in November 2002 and caused severe acute respiratory syndrome (SARS). That virus disappeared by 2004. Middle East respiratory syndrome (MERS) is caused by the MERS coronavirus (MERS-CoV). It is transmitted from an animal reservoir (camels). MERS was identified in September 2012 and continues to cause sporadic and localized outbreaks. The third novel coronavirus has emerged in late 2019 [3].

COVID-19:

A highly infectious pneumonia started to spread in Wuhan, China, from 12 December 2019 [4]. In early January 2020, the officials announced the novel coronavirus as the causative pathogen of the disease [5]. This novel viral pneumonia was named "Corona Virus Disease (COVID-19)" by the World Health Organization (WHO) [6].The name "SARS CoV-2" was also given for this novel coronavirus by the International Committee on Taxonomy of Viruses (ICTV) [7]. Soon, it turned into one of the toughest public health challenges in the modern world having spread in over 200 countries across the globe [8]. In March 2020, the **World Health Organization** (WHO) officially declared it as a global pandemic [9].

The most updated epidemiological and genetic studies performed on infected Chinese patients revealed that this pandemic originated from a zoonosis [10]. Some evidence suggests that the pathogen of COVID-19 originated in some species of bats first, and it was then spread to intermediate hosts such as wild dogs, snakes, and pangolins. The spread to human is thought to have happened via contaminated meat products from traditional wildlife market in Wuhan [11, 12].

Viral structure and pathogenesis:

A SARS-CoV-2 virion is approximately 50–200 nm in diameter. This virus has a +ssRNA genome of approximately 29.9 kb in length. It has four structural proteins, known as the S (spike), E (envelope), M (membrane), and N (nucleocapsid) proteins; the N protein holds the RNA genome, and the S, E, and M proteins together create the viral envelope [13].

Host cell binding and entry are mediated by the spike glycoprotein-S. The first step in infection is virus binding of S protein to a host cell through its target receptor angiotensin-converting enzyme 2 (ACE2). SARS-CoV-2 then uses serine proteases TMPRSS2 (transmembrane protease serine 2) for S protein priming by cleavage of the S proteins at the S1/S2 and S2 sites. This cleavage step is necessary for the virus host cell membrane fusion and cell entry to start its replication cycle[14]. After viral entry, the initial inflammatory response attracts virus-specific T cells to the site of infection, where the infected cells are eliminated before the virus spreads, leading to recovery in most people. In patients who develop severe disease, SARS-CoV-2 elicits an aberrant host immune response. This leads to accumulation of cytokines in multiple organs and causes extensive tissue damage, or a cytokine release syndrome (cytokine storm), resulting in capillary leak, thrombus formation, and multi organ dysfunction [15, 16](figure 1).

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For example, postmortem histology of lung tissues of patients who died of covid-19 have confirmed the inflammatory nature of the injury, with features of bilateral diffuse alveolar damage, hyaline-membrane formation, interstitial mononuclear inflammatory infiltrates, and desquamation consistent with acute respiratory distress syndrome (ARDS), and is similar to the lung pathology seen in severe Middle East respiratory syndrome (MERS) and severe acute respiratory syndrome (SARS) [17, 18].

A distinctive feature of covid-19 is the presence of mucus plugs with fibrinous exudate in the respiratory tract, which may explain the severity of covid-19 even in young adults [19].

Furthermore, ACE-2 receptors present at high concentrations in lungs, myocardial cells, endothelial cells of blood vessels, kidney, liver and intestines, as well as on oral mucosa (especially of the salivary glands and tongue)[20, 21]. These structures have been considered as early targets of Sars-CoV-2 [22]. These findings also indicate that the virus directly affects many organs[23].

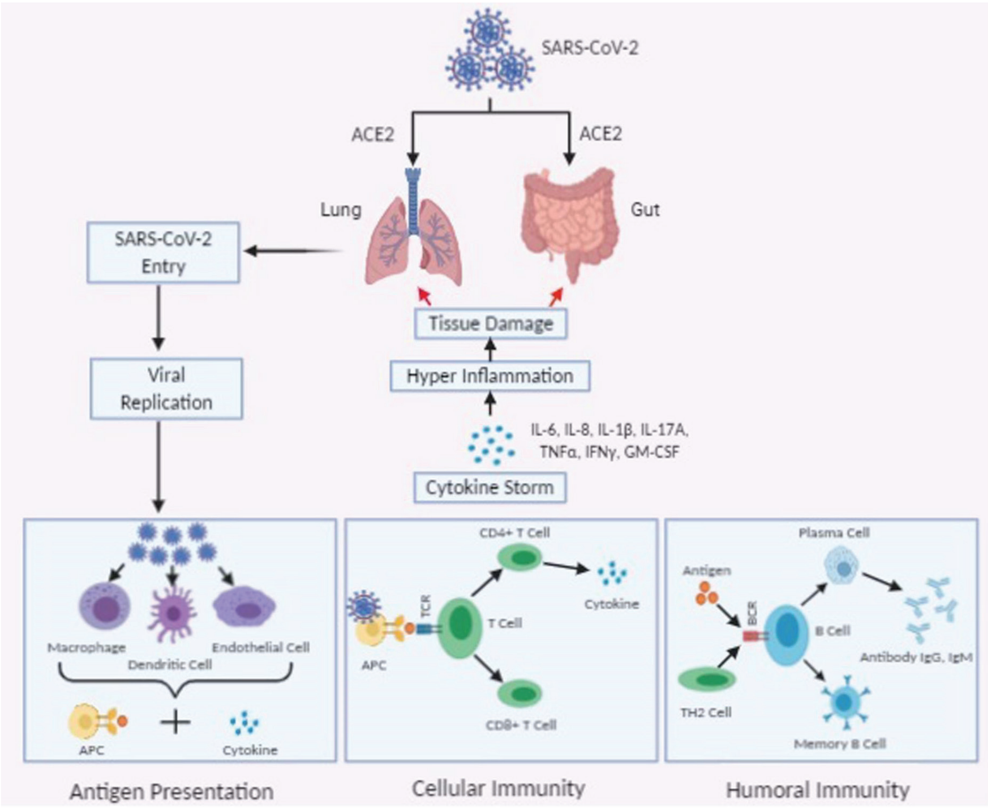

Figure 1: Schematic representation of immunopathogenesis of SARS-COV-2 (23).

Symptoms:

The incubation period of SARS-CoV-2 varies between 3 and 14 days; however, a 24-day incubation period has also been reported [24]. In most instances, the infection brought on by this new coronavirus is asymptomatic or causes few symptoms [2]. Clinical symptoms can vary from case to case. Infected patients mainly exhibit night fever, continuous dry cough, sore throat and asthenia, myalgia or fatigue. Patients with more severe disease can exhibit dyspnea as well as multi organ involvement and dysfunction. The most severe symptoms occur in 15%–25% of infected patients, with a relevant impairment of respiratory function that leads to hospitalization and assisted ventilation[10].

The fatality rate is found to be significantly higher in patients with hypertension, diabetes, and cardio-vascular diseases (CVD) [25-27]. The cause behind this could be the substantial increase in the expression of ACE2 in diabetic and hypertensive patients, treated with ACE inhibitors and angiotensin II type-I receptor blockers (ARBs). This consequently promotes SARS-CoV-2 infection severity [28].

Although loss of sense of smell (anosmia) and taste (ageusia) were not initially evidenced as symptoms of COVID-19, these symptoms are now the earliest indicators of COVID-19 patients [29]. Additionally, there is some new evidence on the impact of COVID-19 on the central nervous system. It suggests that SARS-CoV2, could target the central nervous system, possibly infecting neurons in the nasal passage and disrupting the senses of smell and taste [29].

These symptoms are slightly different from those of severe acute respiratory syndrome (SARS) caused by SARS coronavirus which was widely spread in early 2000s. The differences between SARS and COVID-19 are hidden in their transmissibility and severity pyramids. The transmissibility rate of COVID-19 is reported to be higher than that of SARS [30]. Additionally, in comparison with SARS, a larger population of COVID-19 positive patients demonstrated mild or no symptoms which makes it challenging to diagnose the patients clinically during the incubation period, and therefore, spread of infection can occur at an accelerated rate [31].

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Oral manifestations:

Oral manifestations associated with COVID-19 have been reported. Oral mucosal lesions presented multiple clinical aspects, including, white and erythematous plaques, irregular ulcers, small blisters, petechiae, gingival inflammation and desquamative gingivitis, xerostomia and cracked teeth. Tongue, palate, lips, gingiva, and buccal mucosa were mostly affected. In mild cases, oral mucosal lesions developed before or at the same time as the initial respiratory symptoms; however, in those who required medication and hospitalization, the lesions developed approximately seven to 24 days after onset symptoms [32, 33].

Many physicians continue to question the direct link between SARS-CoV-2 and oral disease. Studies suggested that the mouth might be the most vulnerable area to this virus. The abundance of the ACE2 (angiotensin) receptor in oral tissue could be the main cause. In addition, a new preprint study found that cells of the salivary glands, tongue, and tonsils carry an enzyme called TMPRSS (transmembrane protease, serine 2), which allows the virus to fuse its membrane with that of the host cell and slip inside[34, 35]. Xerostomia may be due to mouth breathing caused by mask use. The surface receptors (ACE2) found in the salivary glands may contribute also to xerostomia [36].

Moreover, bruxism caused by psychological stress from the pandemic could have a major role in stress-related tooth fracture [37]. Despite that, several studies stated that some oral conditions could be secondary to the deterioration of systemic health or due to treatments for COVID-19. They are more likely to present as co-infection. The new coronavirus could have the ability to alter the balance of the oral microbiota, which is added already to a depressed immune system. This would allow opportunistic infections colonization [38-40]. It has been established that correct oral hygiene could decrease the incidence and severity of the main complications of COVID-19 [40, 41].

The most common oral manifestation is Gustatory impairment. As previously mentioned, the mechanism behind this loss is viral disruption of cranial nerves 1, 7, 9, and 10, as well as the supporting cells of neural transmission. In addition, because the tongue has an abundance of ACE2 receptors which provide a direct viral entry into tongue cells[42, 43].

Transmission pathways:

The COVID-19 has similar transmission pathways, but not identical, to those of other SARS-CoV infections, being mainly through the respiratory system. Transmission through droplets and fomites (objects or materials which are likely to carry infection) are the main modes of transmission of SARS-CoV-2. Airborne infection occurs through aerosols and droplets released by infected individuals through coughing, sneezing, exhalation, or speech (figure 2). Direct-contact infection occurs through contact with contaminated surfaces and subsequent touching of eyes, nose or mouth [44, 45].

Dental procedures by their nature have a high risk of COVID-19 infection due to close contact with the patient's oral cavity. Consequently, there is a risk of contact with saliva, blood, and other biological fluids. In addition, the presence of bacteria and viruses in the aerosols created by dental instrumentation such as using a high-speed handpiece or ultrasonic instruments [45]. Therefore, both patients and dental professionals are at a bilateral risk of being exposed to viral pathogens that can be transmitted through the oral cavity and respiratory tract during dental visits [46].

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 [47]. Clinical studies indicated that most of the dental procedures involving use of rotary handpieces generate considerable amount of contaminated and potentially infectious aerosol and droplets [48]. An in vitro study showed that SARS-CoV-2 maintained viability in the air for at least 3 hours and its viability half-life was nearly 1 hour [49].

Moreover, SARS-CoV-2 demonstrates persistent adherence, for a maximum of 9 days, to various surfaces [45, 50]; 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 [46, 47]. The cross-contamination between the attendees to the dental surgery is highly possible in the absence of effective and rigorous cross-infection control protocols[51].

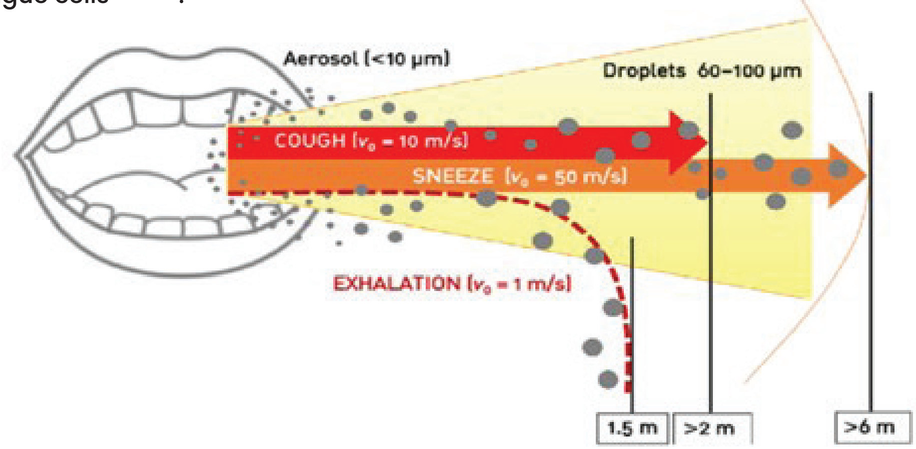

Figure 2: Exhalation distances of aerosol microparticles and large droplets (52).

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The protocol followed in dental office during pandemic:

During the pandemic, updated local guidelines have suggested avoidance of dental treatments, except for patients with emergencies [22]. These dental emergency categories included: • Severe and uncontrolled pain; • Spreading, recurrent or continuing infection; • Avulsed permanent tooth; • Severe trauma [53].
Only urgent treatment for these dental conditions can be performed during the COVID-19 outbreak taking into consideration pharmacological management as the first line and contagion-reduced minimally invasive emergency treatment as the secondary and final management [54].

According to the recommended guidelines during COVID-19, the protective measures that should be undertaken in a dental setting can be categorized into three phases: 1) prior to dental treatment, 2) during the dental procedure, and 3) after dental treatment [54].

Pre-dental treatment measures:

Patient triage is mandatory for initial evaluation of patients. This is for identification of possible suspects, delay of non-urgent dental care and management of dental appointments [54] (figure 3). Dental professionals must be able to screen and identify potential high-risk COVID-19 patients to prevent the spread of the infectious disease. The first screening measure would be taking the body temperature of each patient using a contact-free forehead thermometer. Patients should fill in a questionnaire answering questions to determine if they have had COVID-19 symptoms such as fever, persistent cough and difficulty breathing within the past two weeks. Any contacts with individuals who had tested positive for COVID-19 should be recorded. Patients should also report if they have had contact with at least two people who demonstrated fever or respiratory symptoms within the last two weeks. The social history and any participation in gatherings and meetings need to be noted as well [45] (figure 4).

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 hospitalized.
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. 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 [45, 55].

Decrease in the number of patients attending for dental treatment and their accompanies as well as management of social distancing in the waiting room are among the protective protocols that should be considered [54].

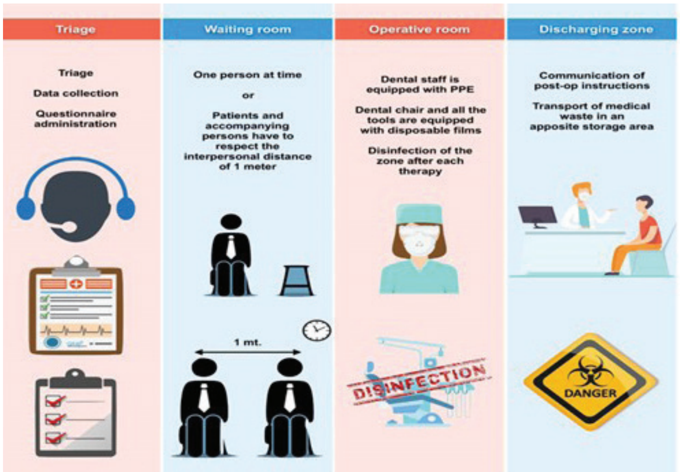

Figure 3: The protocol followed in dental office during pandemic (56).

1. Do you have any fever?	Yes ☐ No ☐
2. Do you have any upper respiratory symptoms?*	Yes ☐ No ☐
3. Do you have conjunctivitis?*	Yes ☐ No ☐
4. Do you or any of your family members or close contact suffer from these same symptoms?*	Yes ☐ No ☐
5. Did you have any contact with patients confirmed with coronavirus disease in the last 14 days?*	Yes ☐ No ☐
6. Have you travelled to outbreak areas of the coronavirus disease in the last 14 days?*	Yes ☐ No ☐

Figure 4: Questionnaire of COVID-19 in dental practice (57).

During dental procedures:

Protective personalized equipment (PPE)

Currently, there is not a practical solution to avoid generation of aerosols mixed with patient's blood and saliva. 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. All dental patients should be considered as potentially infected [58].

In dentistry, the most indicated PPE for airway protection is the Filtering Facepiece (FFP) mask. They 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. The COVID-19 particles are estimated to be 0.06–0.14 μm. According to US standards, FFPs are classified to N95 (95% minimal total filtration efficiency), N99 (99% minimal total filtration efficiency) and N100 (99.97% minimal total filtration efficiency) [46, 59]. In addition to the filtration efficacy, facepieces can be further distinguished as valved or non-valved respirators. Valved respirators can filter the entering air, but do not filter the wearer's exhaled air. Nonvalved respirators provide good two-way protection by filtering both inflow and outflow of air [60]. In dental procedures, it is suggested to use a mask with the highest filtration efficacy without a valve, or a valved mask covered by a surgical mask and the mean surgical period should not exceed 2 hours. The mask also should be considered as disposable [22].

The ocular pathway is known to be one of the most frequent routes of infection with SARS-CoV-2, so eyewear is required during dental procedures. Plastic shields may be preferred to glasses because of their greater capacity to protect the face from aerosol droplets [45].

Disinfection and sanitization

Hand hygiene is considered the most important preventive measure to reduce the risk of transmission of microorganisms between dentists and patients. Soap and cleansers must be rubbed extensively on both hands, until the appearance of abundant foam. Friction with an alcoholic hand sanitizer is suggested after handwashing. These actions have been shown to dissolve the lipid sheath around the viruses, causing dispersion and decomposition of viral molecules [61].

A valid method to reduce the microbial load in the patient's oral cavity is rinsing before dental procedures. There remains controversy regarding the effectiveness of chlorhexidine against coronavirus. Because SARS-CoV-2 is sensitive to oxidation, mouth rinses containing 1% hydrogen peroxide or 0.2% povidone iodine have been proposed [62].

It is crucial that medical and dental teams follow an effective and strict disinfection protocol for both clinical and communal areas. All surfaces in the clinical areas must be cleaned and disinfected to the highest standard according to the local guidelines and requirements. Each potentially contaminated surface should be cleaned and then disinfected with 62%–71% ethanol, 0.5% hydrogen peroxide or 0.1% sodium hypochlorite. 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 [50]. Installation of enhanced air ventilation systems in dental clinics and centers can also help to facilitate removal of airborne pathogens from clinical environments and reduce the risk of infection [63]. Ozone is a natural gas, and one of the most effective systems for environmental sanitization. It provides highly reactive free radicals that can oxidize bacteria, viruses [64]. Germicidal ultraviolet (UV) radiation also represents a valid sterilization option. Ultraviolet light can damage microbial DNA and RNA, thus preventing reproduction of microbes and reducing the harmful effects of infectious organisms [65].

Mechanisms to reduce spread of COVID-19 in the dental environment.

Handpieces with an anti-retraction system should be used during the COVID19 pandemic. 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. Rubber dam usage also provides a 70% reduction of droplets around the surgical field [54]. When isolation using a rubber dam is not possible, manual instrumentation is preferred over high-speed handpieces [45]. Simultaneous assembly of two ejectors (e.g., a high-speed ejector and a high-volume evacuator) is highly recommended to achieve considerable reduction of droplet spread during dental procedures. When possible, it is recommended to avoid dental procedures that could cause cough and regurgitation [22].

Orthopantomography (OPG) or cone beam computed tomography (CBCT) are preferred; periapical X-rays should be avoided because they could provoke hypersalivation, coughing or vomiting [55].

After dental treatment:

Clinical Waste Management

Clinical waste should be stored in a safe temporary storage area, and all reusable instruments and items should be pre-treated, cleaned, sterilized, and properly stored in accordance with the local protocols. The clinical waste generated after treatment of COVID-19 positive patients must be regarded as infectious clinical waste and stored in clinical waste bags within a designated area. The surface of the package bags should be marked and disposed according to the local regulations and requirement for the management of medical waste [45].

COVID-19 Testing:

There are various methods available for COVID-19 testing, and the decision to carry out a test on suspected individuals should be made based on clinical symptoms and epidemiological factors. It would be beneficial if dental practices were provided with fast COVID19 detection kits in order to test the high-risk and suspicious patients. This way, they can take necessary precautions in reducing the spread of the virus [31].

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RT-PCR

Also called a molecular test, this COVID-19 test detects genetic material (RNA) of the virus. As per WHO guideline, the RT-PCR test should be done in asymptomatic or mildly symptomatic patients and those who have had contact with COVID-19 positive cases. A swab is normally utilized to gather specimen from inside the nose or posterior part of throat [66].

Serological or Antibody Testing

Another method of investigation in an ongoing pandemic is serological survey of cases. This test detects antibodies produced by the immune system in reaction to viral infection. This method tests whether a suspected individual has been infected by COVID-19 and has produced antibodies. The immunological reactions to the SARS-CoV-2 can take several weeks to happen, and some studies show that antibodies to COVID-19 may take 14 days to appear. Therefore, a serology test before this period may result in an unhelpful negative. Antibody test requires a blood sample from the patient [67].

Antigen test

This COVID-19 test detects certain proteins in the virus. A fluid sample is obtained by long nasal swab. There is an increased chance of false-negative results. The doctor may recommend a PCR test to confirm a negative antigen test result [68].

Medical imaging

The CT scan may present some findings even before the onset of symptoms [60]. Bilateral multilobed ground-glass opacifications associated with a peripheral asymmetric and posterior distribution is the typical feature of the CT in COVID-19 positive cases. A comparative study conducted in Wuhan suggests that CT is significantly more sensitive than PCR test; however, it is less specific as many of its imaging characteristics overlap with other types of pneumonia [69].

Treatment of COVID-19:

Potential interventions including pharmacologic treatments for novel coronavirus (COVID-19) disease have been comprehensively and systematically reviewed. General supportive treatments such as vitamins (A, B, C, D and E),
Immuno-enhancers including interferons and antiviral medications such as ribavirin, remdesivir and nelfinavir are examples [70, 71]. A large number of clinical trials are currently underway in many countries globally to investigate the suitability of some of these interventions individually or as combination therapies against COVID-19 [31].
Yet, the U.S. Food and Drug Administration (FDA) approved an emergency use authorization (EUA) for the monoclonal antibody "bamlanivimab" and the antiviral drug "remdesivir" for treatment of adult and pediatric patients with COVID-19 [72, 73]. Remdesivir provides only a modest benefit to patients [74].
Still, the pandemic's biggest puzzle is that why some people with coronavirus have no symptoms and others get extremely ill? A study in Nature of more than 2,200 intensive care patients has identified specific genes that may hold the answer. This is done by sequencing of patients' genes. A mutation in gene called TYK2 makesthe immune response to go into overdrive, putting patients at risk of damaging lung. Genetic differences were also found in a gene called DPP9, which plays a role in inflammation, and in a gene called OAS, which helps to stop the virus from making copies of itself [75].

Variations in a gene called IFNAR2 were also identified in the intensive care patients. The gene IFNAR2 is linked to interferon, which helps to start the immune response to the infection. This mutation causes too little production of the interferon which can give the virus an early advantage, allowing it to quickly replicate, leading to more severe disease [75]. Two other recent studies published in the journal Science have also implicated interferon in COVID cases, through both genetic mutations and an autoimmune disorder that affects its production [76, 77]. Interferon was given as a treatment, but a World Health Organization clinical trial concluded that it did not help very sick patients [74].

The findings from these genetic studies will help to identify particular molecular pathways that could be targets for therapeutic intervention [75]. Additionally, large-scale clinical trials are required to approve the efficacy of these target therapies.

Vaccines of COVID-19:

Multiple vaccine development strategies such as virus vaccines, recombinant protein subunit vaccines and nucleic acid vaccines are being evaluated for their safety and efficacy [78].
Researchers are currently testing 63 vaccines in clinical trials on humans, and 18 have reached the final stages of testing. At least 85 preclinical vaccines are under active investigation in animals [79]. The F.D.A. has authorized **PfizerBioNTech** vaccine and Moderna's vaccine for emergency use on 11 December and 18 December, 2020, respectively [80].

Tozinameran (INN), codenamed BNT162b2, commonly known as the Pfizer–BioNTech COVID-19 vaccine is an RNA vaccine composed of nucleoside modified mRNA (modRNA) encoding a mutated form of the spike protein of SARS-CoV-2, which triggers an immune response against infection [81]. Moderna's technology is also modRNA compound named mRNA-1273, which induces immunity to SARS-CoV-2 by encoding a prefusion stabilized spike (S) protein naturally present on the surface of SARS-CoV-2 particles. The drug delivery system of mRNA-1273 uses a PEGylated lipid nanoparticle drug delivery (LNP) system [82].
Both the Pfizer and Moderna use technology known as mRNA, which introduces into the body a messenger sequence that contains the genetic instructions of the virus. The vaccinated person's own cells produce the antigens and generate an immune response. Moderna vaccine has higher mRNA amount per dose (100 micrograms) compared with Pfizer vaccine containing 30 micrograms of mRNA perdose [83].

Potential Long-Term Impact of COVID-19 on Dentistry

Authors' observations and evaluation of the current situation suggest that the costs of providing dental treatment may increase in the future because of several reasons. The need for additional resources such as PPE, dental practice modifications would primarily raise the treatment costs. The need for segregation of patients in the waiting areas resulting in a reduced number of patients that can be seen daily. Additionally, due to an increased occupational health risk to the practitioners arising from carrying out aerosols generating procedures, the cost of specialist services may possibly increase [54].

There could be a general fear of visiting dentists among the public after the COVID-19 outbreak settles down. Consequently, some patients will pay more attention to their oral and dental health by improving their oral hygiene practice and following preventive recommendations [31]. Higher levels of oral hygiene could decrease the need for a person to attend a dental clinic; and at the same time, it can significantly help the person to remove the virus from the body in the early contamination phase [84]. Good oral hygiene also reduces the bacterial load in the mouth and the risk of bacterial superinfection especially in patients who are prone to altered biofilms due to diabetes, high blood pressure or CVDs [85].

Furthermore, Due to overall economic impact of COVID-19, extended lockdown measures and closure of dental clinics and centers, it is predicted that there could be further uncertainty for the profession, reduced incomes, and more job loss in the future. Some small to medium-size dental related businesses may not survive a long-term lockdown [54].

Tele-dentistry:

Tele dentistry is a great innovation to minimize the risk of increased COVID19 dissemination and cross infections at medical or dental offices. Tele-medicine (TM) is a new concept of healthcare to deliver care across distance using advanced communication technologies (smartphones, tablets, and laptops) [86, 87]. The TM completely modified the traditional medical approach of working. The American Dental Association (ADA) describes tele dentistry as "a broad variety of technologies and tactics that deliver virtual medical, health and education services" [88].

There are different (but not limited) key modalities of tele dentistry as described by ADA. These include the following: 1) Synchronous: Live video, two-way interaction between the patient and the tele dentist by utilizing audio-visual telecommunication. 2) Asynchronous: Recorded medical and dental information such as clinical photographs, radiographs and videos are sent by secure telecommunication to the clinician for evaluation and advice. 3) Remote patient monitoring (RPM): Personal medical and dental data collected from an individual in one location is transmitted to the provider by secure telecommunication in a different location. 4) Mobile Health: Use of mobile communication devices for public healthcare, education, and practice [88].

During this ongoing global COVID-19 pandemic, tele dentistry is a viable care option in efforts to help 'flatten the curve'. It is the dental health professional's ethical and professional obligation to limit that risk and prevent the spread of COVID-19 in vulnerable patients and act in accordance with regulatory requirements. It is therefore imperative for dental practitioners to understand that tele dentistry is the practice of online dentistry and that they have a duty of care to the patient [89]. More recently a study utilizing tele dentistry has shown that this allowed monitoring of all patients with reduction in cost and limiting human contact [90].

One of the most significant advantages of tele dentistry or telemedicine include real-time consultations and assessments, storage of data, a reduction in travel for patients and clinicians saving time and cost. In addition, it provides faster access to dental and specialist care, collaborative, and educational tool by giving an opportunity to discuss with family members or fellow clinicians (after patients consent) as well as improved access of care to rural community who are unable to travel to larger cities. Meanwhile, disadvantages can include the exchange of sensitive information, the commitment to confidentiality, the commitment to security and access to a large volume of data stored [88]. It is assumed that the COVID-19 pandemic may cause a permanent transformation in dentistry with the advancement of tele-dentistry [91].

Conclusion:

The COVID-19 has spread worldwide in a pandemic way and infection control measures are mandatory to limit contagion, especially for healthcare professionals who meet potentially infected patients. To date, there is a consensus in providing only emergency dental services, but the situation is constantly evolving. In any case, the reduction of infectious risk remains a challenge for dentists, among the most exposed health professionals.

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