Review Article

Coronavirus: An emerging and future challenge for dental clinicians

ABSTRACT

The first case of pneumonia of unknown origin was identified in Wuhan, the capital city of Hubei province situated in the Republic of China. The pathogenic organism that has been identified as a causative organism is a novel enveloped RNA betacoronavirus which has been designated as' severe Acute Respiratory Syndrome Coronavirus- 2 (SARS-CoV-2). This virus has been found to have a similar phylogeny to SARS-CoV. The novel Coronavirus or COVID-19 can be symptomized through clinical manifestations like- Pyrexia or fever, Cough, Dyspnea/ difficulty in breathing, Myalgia/muscle pain, and constant fatigue. In the later stages, these symptoms worsen leading to severe pneumonia, acute respiratory distress syndrome, sepsis, and multiple organ failure. These days, this pandemic is emerging as a major threat for dental health-care professionals. The dental surgeons are at greater risk of novel coronavirus infections due to direct contact with infected patients and exposure to contaminated blood, saliva, and other body fluids. This article deals with viral structure, clinical symptoms, and modes of transmission, recommended measures to prevent its spread in dental operatories.

Keywords: Dental, pandemic, severe acute respiratory syndrome coronavirus 2

INTRODUCTION

The currently ongoing nCOVID-19 pandemic is caused by the SARS-CoV-2 coronavirus.[1] The outbreak and faster diffusion of SARS-CoV-2 which is responsible for coronavirus disease (COVID-19), has caused an emergency in the health and education system worldwide.[2] Four known human coronaviruses primarily cause mild to moderate degree of upper respiratory tract diseases which include- alpha- and beta- coronaviruses. The severe acute respiratory syndrome (SARS) and Middle-East Respiratory Syndrome (MERS) are the recent viral strains that caused pandemic disease. The coronaviruses responsible for human diseases are the beta corona strains. These viruses possess great ability to undergo mutations therefore; posing more challenges.[1] The COVID-19 infection spreads from human to human transmission mainly through fomites and droplet infection.[3,4]

There are six species of this strain which are known to cause pathologies among humans. Four of these are prevalent forms namely, OC43, HKU1, NL63 and 229E. These strains are responsible for symptoms of common cold in immunocompetent subjects. Remaining two strains- Middle East Respiratory Syndrome Coronavirus (MERS-CoV) and Severe Acute Respiratory Syndrome Coronavirus (SARS-

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CoV) have a zoonotic origin and can sometimes result in fatality. Phylogenetic analysis of bronchoalveolar lavage samples showed that this virus comes under the genus 'Betacoronavirus'.[5]

This typical virus is more likely to affect older adults and children to cause severe respiratory diseases; however, new evidence implicates threats to younger adults.[6] The estimated incubation period of the virus is between 1 and 14 days. Symptoms may vary from the presence of fever and dry cough to nonspecific symptoms such as shortness of breath, conjunctivitis, sore throat, diarrhea, vomiting, fatigue, and myalgia.[7]

The treatment of SARS-CoV-2 is mainly supportive and based on symptoms. Hence, adequate isolation for the prevention of transmission is important. Mild symptoms can be managed at homes with the maintenance of adequate hydration, appropriate nutrition, and control of fever and cough. The use of antibiotic and antiviral agents must be avoided in positive subjects. Hypoxic subjects are supported with oxygen supply using a high-flow nasal cannula or noninvasive ventilation. Renal replacement therapy may be required. The rapidly rising numbers of cases of this virus around the world have led to a generalized fear which has been termed as "Coro Phobia". This virus is transmitted through the respiratory tract route.[8] COVID-19 can manifest clinically as asymptomatic carrier, acute respiratory symptoms, and pneumonia. Neonates, children and older adults can also get infected alongside. Among the most prevalent pre-existing diseases found in COVID-19 patients under hospitalization include hypertension, cardiovascular disease, chronic renal diseases, malignancies, and chronic obstructive pulmonary disease. The exact rate of SARS-CoV-2 transmission is unknown although human to human transmission is evident due to its wide prevalence among family members and workers related to health care services. Since it is a newly identified pathogenic microorganism, there is no acquired immunity existing among humans. At present, there is no evidence for its transmission route through vaginal delivery or through breastfeeding although newborn infants should be protected from exposure to infected subjects.[9]

Dental professionals appear, indeed, at high risk of contagion due to the exposure to saliva, blood, and aerosol/droplet production during the majority of dental procedures.SARS-CoV-2 transmission during dental procedures can therefore happen through inhalation of aerosol/droplets from infected individuals or direct contact with mucous membranes, oral fluids, and contaminated instruments and surfaces.[10]

STRUCTURE OF SEVERE ACUTE RESPIRATORY SYNDROME CORONAVIRUS 2 TRANSMISSION

The SARS-CoV-2 is a spherical shaped, positive, single-stranded RNA viral particle. This virus has spiked projections. It has been derived from Latin 'corona' which means 'crown'. This conforms to their shape resembling a royal crown under an electron microscopic view. These are enveloped viral particles. The envelope is composed of a lipid bilayer which is derived from the host cell membrane with structural proteins embedded within this envelope. These include- spike (S), membrane (M), envelope (E) and nucleocapsid (N) proteins. The 'N' protein is bound to the RNA forming nucleoprotein. S protein is a glycosylated protein forming homotrimeric spikes. This protein mediates the entry of viruses within host cells. The M protein is responsible for providing the virus its shape and is found in the largest amount. The E protein causes the release of viral particles from host cells. The CoV genome is the second largest amongst all RNA viruses. Its weight ranges between 26 to 32 kilobases (kb).[10] ACE-2 associated genes are responsible for various biological processes such as- viral metabolism and immunological responses. Elevated ACE-2 levels have been found in oral epithelial cells and intra-pulmonary airway but not among non-smokers or those who had quit the habit of smoking. The binding process has been demonstrated between the SARS-CoV-2 spike (S) glycoprotein receptor-binding domain (RBD) and Angiotensin-Converting Enzyme 2 (ACE-2) receptor. The 'S' protein of COVID-19 has structural similarity with SARS-CoV, hence, exploits the ACE-2 receptor for infection among hosts.[11]

It is also of note that SARS-CoV -2 can bind to the human angiotensin converting enzyme 2 (ACE2), and cells from human, bat, cat, and pig, but it cannot bind to the cells without ACE2. SARS-CoV -2 promotes human-to-human transmission through the ACE2+ cells. Such cells are located in the epithelium of the respiratory tract and the ductal epithelium of the salivary glands in the mouth.[11,12].

The pathogenic microorganisms can be transmitted in dental settings through inhalation of airborne microorganisms that can remain suspended in the air for long periods, direct contact with blood, oral fluids, or other patient materials, contact of conjunctival, nasal, or oral mucosa with droplets and aerosols containing microorganisms generated from an infected individual and propelled a short distance by coughing and talking without a mask, and indirect contact with contaminated instruments and/or environmental surfaces.[11,13,14]

SPREAD OF CORONAVIRUS 2 IN DENTAL SETTINGS

Aerosols/Droplets

The dental rotary equipment operating at a very high speed generate aerosol droplets that are mixed with patient's saliva and blood.[15] Small particles of droplets and aerosols remain airborne for a large period of time before settling over any surface or entering the respiratory tract. Hence, 2019-nCoV can have a potential of spreading from infected patients in dental operatories.[11]

Contaminated surfaces of instruments

nCOVID-19 can persist on the contaminated surfaces of dental instruments and the equipment placed in dental settings such as metal, glasswares, and plastic surfaces for many hours. Dental professionals and even hospital staff come in contact with these contaminated surfaces frequently and thus become the source of coronavirus spread.[15]

Transmission through transplant

Fecal microbiota transplantation (FMT) is a new treatment method which has rapidly earned a major role in the management of recurrent *Clostridioides difficile* infection due to its clear advantages over antibiotics use. FMT is also being evaluated and considered an experimental treatment for other diseases including irritable bowel syndrome, nonalcoholic steatohepatitis, hepatic encephalopathy, obesity, and neurological diseases.[16] *C. difficile* infections result due to the good gut bacteria being killed by antibiotics given for other infections and cause severe diarrhea and abdominal pain and may be fatal in elderly patients. During FMT, the good bacteria in the faces of a healthy donor are transferred to the gut of a patient with the infection. The risk SARS-CoV-2 transmission by means of FMT might be greater than other tissue transplants. There is evidence that SARS-CoV-2 can be traced in fecal samples. Stool samples can remain positive for the virus long after it is undetectable in the respiratory tract, suggesting that there is a possibility of fecal–oral transmission route. This hypothesis can be supported by gastrointestinal symptom subjects who are affected by COVID-19.[7] It is anticipated that transplant recipients may have a greater viral burden and shedding resulting in greater infectivity and potential spread to other individuals.

CLINICAL SYMPTOMS AND RESPIRATORY DISEASES IN COVID-19

Analysis of viral genome has suggested that SARS- CoV- 2 is a recombinant virus between bat and an unidentified origin coronavirus. The human transmission is thought to be possibly taken place from animals. However, there is still an inconclusiveness regarding the exact animal origins of human beings from bats, snakes, or any other animal in a chain of transmission. But there are positive findings about this virus from samples obtained from the sea-food industry and markets. Respiratory droplets derived from coughing or sneezing are primary sources for human to human transmission. Most frequently reported symptoms of respiratory illnesses due to COVID-19 include- higher fever than 38.1°C (98% cases), severe cough (in 76% cases), and severe fatigue or myalgia (observed in 44% patients). Dyspnea appears in 55% infected subjects after eight days and is the first severe complication of this disease. Also, diarrhea, headache, dyspnea, and hemoptysis have been reported as other clinical symptoms of COVID-19.[17]

The pneumonia caused by SARS-COV-2 is a highly contagious condition. Zhou et al (2020) conducted a study in sixty-two patients with COVID-19 pneumonia in Wuhan, China. They found that symptoms of fever (87.1% cases), cough with sputum (45.2% cases), pain in muscles (32.3% cases), difficulty in breathing (24.2% cases), fatigue (22.6% cases) and also, gastrointestinal symptoms such as pain in abdomen and diarrhea (14.5% cases) constitutes presenting symptoms of COVID-19 infection. These findings suggested the binding of viral particle to Angiotensin-converting enzyme receptor which is highly expressed in the gastrointestinal tract of humans. These investigators found diverse patterns using Computed Tomography among COVID-19 pneumonia affected patients. These include- consolidation, reticular pattern, vacuolar sign, subpleural lines, bronchial changes such as- distortion, pleural retraction sign, and pleural effusion. Mixed patterns are found to affect both lung interstitium and parenchyma.[18] Chest imaging shows bilateral ground-glass opacities.[19]

The Coronavirus pandemic has been preceded by two epidemics caused by betacoronavirus family viz., Middle East Respiratory Syndrome coronavirus (MERS-CoV) and Severe Acute Respiratory Distress Syndrome Coronavirus 2 (SARS-CoV-2).[20,21]

Laboratory features

Laboratory findings specific to SARS-CoV-2 include:

- Elevated prothrombin time, lactate dehydrogenase, D-dimer, aspartate transaminase, C-reactive protein (CRP), and creatine kinase. Levels of CRP correlate directly with disease severity and progression[22]
- In the early stages of the disease, a marked reduction in CD4 and CD8 lymphocytes can also be noted
- Sever symptomatic cases show higher levels of interleukin (IL)-2, IL-7, IL-10, granulocyte colony-stimulating factor, interferon gamma-induced protein 10, monocyte chemotactic protein 1, macrophage inflammatory

protein-alpha, and tumor necrosis factor[23]
- In critical patients, amylase and D-dimer levels are significantly elevated.[24]

DIAGNOSTIC VALUE OF SALIVA FOR 2019-NCOV

Saliva is a common and transient medium for coronavirus transmission. The detection of 2019-nCoV nucleic acid from throat swabs confirms the presence of pathogen. Throat swabs are relatively invasive, induce coughing, and cause bleeding occasionally, which may increase risks of health-care workers' infection. With the nature of noninvasion and less hazard to health-care workers, saliva specimen collection has the advantages of being more acceptable for patients and more secured for health-care workers for diagnosis of coronavirus. Till now, three approaches have been reported to collect saliva – coughing out, saliva swabs, and directly from salivary gland duct.[25]

For acquisition of infectious saliva droplets by a susceptible host, infectious saliva droplets could land in month, eyes, or be inhaled into lungs directly.[26] Saliva droplets are generated when breathing, talking, coughing, or sneezing and formed as particles in a mixture of moisture and droplet nuclei of microorganisms. The amount, distance, and size of saliva droplets vary among people, suggesting that the infectious strength and transmission path of saliva droplets differ when the same pathogen was contracted. Three thousand saliva droplet nuclei could be generated by one cough, which nearly equals to the amount produced during a 5-min talk.[27]

Large droplets (diameter $>60\ \mu$m) tend to quickly settle form the air, so the risk of pathogen transmission is limited to individuals in close proximity to the saliva droplet source. Small droplets (diameter $\leq 60\ \mu$m) may get involved in short-range transmission (distance between individuals <1 m). Small droplets are likely to evaporate into droplet nuclei (diameter $<10\ \mu$m) in favorable environment and then become potential for long-distance aerosol transmission.[28]

PROPHYLACTIC MEASURES IN DENTAL OPERATORIES TO LIMIT CONTAGION

During the dental procedures, the uses of a high-speed handpiece or ultrasonic instruments generate aerosols that get mixed with patient's saliva and blood. Dental apparatus gets contaminated with various pathogenic microorganisms after the use or becomes exposed to a contaminated clinic environment. Thus, various dental procedures can lead to the spread of COVID-19 infection. The various effective infective control measures that can be followed include:

- If the patient is suspected of any sign and symptoms of coronavirus infection, the dental treatment must be postponed
- Only the emergency dental treatment can be delivered in an environment with proper air exchange using personal protective equipment, including masks, gloves, gowns, and goggles or face shields, As respiratory droplets are the main route of SARS-CoV-2 transmission, particulate respirators (e.g., N-95 masks authenticated by the National Institute for Occupational Safety and Health or FFP2-standard masks set by the European Union) are recommended for routine dental practice[29]
- Hand hygiene has been considered the most critical measure for reducing the risk of transmitting microorganism to patients. Wash your hands frequently with soap and water counting up to 20 (approximately 20 s)[30]
- Eye protection and contact preventative measure should be added in the dental clinic setups
- The four-handed technique is beneficial for controlling infection in dental clinics. The use of saliva ejectors with low or high volume can reduce the production of droplets and aerosols.

Apart from dental practice, few basic recommendations for dental educational institutes during this outbreak are necessary: dental students should be encouraged to make the use of smart devices and applications in order to attend online lectures, case presentations, and problem-based learning tutorials, thus avoiding unnecessary aggregation of people and associated risk of infection.[19] Dental education institutes must encourage the students to engage in self-learning, make full use of online resources, and learn about the latest academic developments.[29]

The importance of teleconsultation services has now become a critical need for populations and patients affected by the COVID-19 infection, especially when under active quarantine. Enabling patients to consult a dentist via teleconferencing, in real time, to allay one's fear and anxiety, seek advice regarding their routine health problems, and learn self-care, all become critically important in the setting of hospitals and clinics being overwhelmed with more acute complaints.

PREPARATION OF OPERATING UNITS

The changes required in the dental operatories to prevent infection transmission include:

1. All the surfaces surrounding the dental chair must be clean in order to prevent contamination. The free surfaces are easy to clean and disinfect

2. The protective barriers must be applied on the fixed surfaces around the operating field (lamp, quiver, armchair control tablets, push-button panels, and handles), to protect them from splashes and the fall of the aerosol
3. Cover the headrest of the chair with disposable protection
4. Remove the bib fasteners and replace them with adhesives or with knotting bibs.

As per the protocols, all the surfaces exposed to contact by aerosol fallout and splashes must be decontaminated and disinfected with specific chemical agents in the following ways:

1. Remove the protective barriers
2. Disinfect surfaces with products possibly based on:
    - 65/70% ethyl alcohol paying attention to the contact times so that the rapid evaporation of the product does not affect the result and does not alter the leather surfaces
    - 0.1% hypochlorite used with caution to avoid stains, corrosion, and bad odor
    - Disinfect the armchair with particular attention to the headrest and surrounding areas more exposed to splashes or aerosols, proceeding from the outermost parts of the armchair and terminating with the cuspidor
    - Disinfect the seat and, in particular, the handle of the sliding rail.

Do not spray the product directly on the surfaces, but on a disposable paper cloth to avoid inhalation during use. Prefer disinfectant wipes ready to use available both alcohol free for sensitive surfaces and/or with alcohol.[31]

- Respect the contact times necessary for the degradation of microorganisms
- Carry out a first step to remove, cleanse, and decontaminate the surface and a second to disinfect them
- At the end of each operating procedure, the aspirators must be flushed for a period of time with appropriate decontaminants/disinfectants
- The operatory must be fumigated at regular intervals, especially after the aerosol-generating procedures.[31]

MEASURES TO LIMIT THE SPREAD OF COVID-19 INFECTION IN DENTAL OPERATORIES

Patient triage and screening

During the outbreak of COVID-19, dental clinics are recommended to establish precheck triages to measure and record the temperature of every staff and patient as a routine procedure. Dental clinic staff should evaluate the patients on the basis of the health status and history of contact or recent travel. Before the dental treatment procedures, patients and their accompanying persons must be examined for body temperature. Patients with fever should be registered and referred to medical hospitals. Any patient with a history of recent travel to an epidemic region should be isolated for at least 14 days before any dental procedure.

Examination of oral cavity and preprocedural mouthrinse

Before examining the oral cavity, a patient should be asked to rinse with antimicrobial mouth rinse in order to reduce the microbial load in the oral cavity.[32] It is recommended to use mouthwash containing oxidative agents such as 1% hydrogen peroxide or 0.2% povidone for the purpose of reducing the salivary load of oral microbes.[11]

All the dental procedures that generate aerosols in excess and induce salivation and coughing should be avoided or performed cautiously.[33] The use of a three-way syringe should be minimized as much as possible. Examination of the oral cavity using intraoral radiographs should be minimized in order to reduce the risk of salivary stimulation and cough. Thus, the use of alternative radiographic methods such as orthopantomograph and Dentascan must be encouraged during pandemic outbreak.

Frequent hand wash

Hand hygiene is considered to be a critical measure for reducing SARS-CoV-2 transmission. It is crucial to perform thorough hand washing when coming into contact with patients and nondisinfected surfaces or equipment, and it is recommended to avoid touching eyes, mouth, and nose without having hands carefully washed.

Use of protective equipment

Due to airborne spread of COVID-19 it is mandatory to use protective equipment, including gloves, masks, protective outerwear, protective surgical glasses, and shields to protect eye, oral, and nasal mucosa. The use of rubber dam isolation and anti-retraction handpieces should be encouraged. Rubber dam along with high power suction reduces the risk of saliva and blood-contaminated aerosol or spatter production. It has been reported that the use of rubber dam significantly reduces the airborne particles in ~3-foot diameter of the operational field by 70%.[34]

It is necessary to use handpieces with anti-retraction valves as the microorganisms such as bacteria and viruses may contaminate the air and water tubes within the dental unit and thus can potentially cause cross-infection. Thus, these anti-retraction

valves prevent the backflow of oral microbes into tubes and dental units, thereby minimizing the risk of cross-infection.[11,35]

Whenever pharmacologic management of pain is required, ibuprofen should be avoided in suspected and confirmed COVID-19 cases.[6]

Biomedical waste disposal

It is necessary to dispose the medical waste from dental operatories with proper care.

The medical and domestic waste generated by the treatment of patients with suspected or confirmed SARS-CoV-2 infection is regarded as infectious medical waste. The infected waste should be pretreated first with chemicals then disposed. Biomedical waste management should be appropriately done using double-layer yellow color waste package bags and proper ligation of these at necks.[11] The surface of the package bags should be marked and disposed according to the requirement for the management of medical waste.

CONCLUSION

Dental professionals appear extremely exposed to the risk of SAR-CoV-2 infection, thus making necessary protocols and strict preventive measures are recommended to limit the spread of infection in dental settings.

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Conflicts of interest

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