JODR

Volume 7, Issue 2,2020

Journal oF Oral and Dental Research

IAOR
IRAQI ASSOCIATION FOR ORAL RESEARCH
Iraqi Division of the IADR

Can Digital Work and Lasers Lessen the Impact of COVID19 to Dentistry and Oral Surgical Procedures? A Literature Review

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Received July 10, 2020.
Accepted for publication in July 27, 2020.
Published August 17, 2020.

Abstract
Oral surgical and dental procedures require close physical operator-patient position, and deal with two important infectious routes of the 2019 novel coronavirus (COVID19), saliva and blood. This review focuses on viral characteristics, cell recognition and clinical presentation of COVID19 infection, briefly in comparison to other related coronaviruses. Followed by the most important diagnostic and transmission means with preventive measures to be considered throughout and after the pandemic infection period, to protect general practitioner dentists, oral surgeons and other health care professionals against this rapidly spreading infection, utilizing recent digital technologies and lasers.

Keywords: COVID19; digital; lasers; oral surgery

Introduction

A global health emergency was declared on 30th of January 2020, owing to a viral pneumonia outbreak. This viral pneumonia that started in Wuhan was attributed to a new coronavirus, the member number 7 of the coronaviruses family that infects humans (Peng et al, 2020). Chen et al, 2020; Wu et al, 2020; Zhou et al, 2020, on 11th of February 2020, it was called "Corona Virus Disease (COVID19)" by the World Health Organization (WHO) and then renamed to "SARS CoV2", by the coronavirus study group (CSG) of the international Committee on Taxonomy of Viruses (ICTV), encountering the phylogenetic and taxonomic analysis of the recent coronavirus. (Gorbalenya, 2020).

Viral background

Coronaviruses (CoVs) a big family, Coronaviridae, that comprises enveloped large positive single-stranded RNA viruses, these are capable to infect a wide variety of animals as well as humans (Weiss and Leibowitz, 2011;Yin and Wunderink, 2018). Upon reviewing previous studies, it seems that bats and birds are the natural reservoir of these viruses, including the four documented groups (α, β, γ and δ), with bats being a favourable host of the former two groups, whereas the latter two groups might be ideally hosted by birds. Despite the presence of the four coronavirus groups circulating around the earth for centuries (Woo et al, 2012), human

coronaviruses (HCoVs) were considered to be relatively harmless respiratory pathogens, until an outbreak of the severe acute respiratory syndrome (SARS) in 2002-03 had occurred, followed by the emergence of the Middle East respiratory syndrome (MERS) in 2012 (Yin and Wunderink, 2018) and the recent (COVID19) in 2019, that rendered HCoVs to be an important respiratory tract pathogen which receive attention all over the world.

Characteristics of COVID19

The COVID19 belongs to the Beta coronavirus genus, similar to SARS and MERS CoVs. Similarity of COVID19 genome ranges from about 50% to less than 80% with that of MERS and SARS respectively; never the less, it is NOT a descendent of any of these viruses and their introduction into humans was enabled by external factors (Chan et al, 2020; Chen et al, 2020; Gorbalenya, 2020; Peng et al, 2020).

Clinical presentations of COVID19

The most frequent symptoms are predominantly fever (98.6% of studied cases), followed by fatigue, dry cough, myalgia, and dyspnea. Whereas, other symptoms like; headache, dizziness, abdominal pain, diarrhea, nausea, and vomiting are less frequent (Wang et al, 2020). Ongoing clinical studies show that clinical, laboratory, radiological and epidemiological features along with the incubation period of COVID19 are close to that of SARS CoV. (Chan et al, 2020). Clinical presentations range from asymptomatic (Bai et al, 2020; Chan et al, 2020) to severe pneumonia that may cause death. About (80%) of cases are mild respiratory infections and pneumonias; however serious illness and death are more prevalent among old aged with other chronic underlying conditions. (Euro surveillance Editorial Team, 2020), besides, a major role of innate and adaptive immunity was perceived, against COVID19 infection, due to higher likelihood of comorbid, older men involvement and cluster infection onset (Bai et al, 2020; Chan et al, 2020; Chen et al, 2020).

Cell entry

Although the spike surface glycoprotein of COVID19 differs from that of SARS CoV, both viruses can bind to human Angiotensin Converting Enzyme II (ACE2). Wu et al, 2020; Zhou et al, 2020; Wan et al, 2020, suggesting that the population with higher ACE2 expression might be more prone to COVID19 infection (Peng et al, 2020). Nevertheless, both viruses can be potently neutralized, in vitro, by ACE2 fusion proteins (Lei et al, 2020; Wan et al, 2020). It is worthy to mention that ACE2 abundantly present throughout the human respiratory tract and salivary gland duct epithelium in the oral cavity. Liu et al, 2011, explaining viral detection in the nasopharyngeal, oropharyngeal and saliva secreted via these tissues (Chan et al, 2020; Guan et al, 2020; Huang et al, 2020; Wang et al, 2020). on the other hand, the ocular anatomical proximity to respiratory tissues and documented ocular involvement after respiratory viral infection (Belser et al, 2013); clears the eye role to transmit COVID19 (Lu et al, 2020).

Virus detection and Viral load

Basically, real-time reverse-transcriptase polymerase-chain-reaction (RT-PCR) assay is the method of choice to detect COVID 19 genome in nasopharyngeal, oropharyngeal (Guan et al, 2020; Wang et al, 2020) and saliva samples. K. K.-W. To et al, 2020, noticed that identical respiratory virus was detected in both nasopharyngeal aspirate and saliva, with a statistically significant higher cycle threshold values in the latter sample, representing a higher viral load and earlier presence of the pathogen in saliva (Jeong et al, 2014; K. To, Yip, et al, 2019; K. K. To et al, 2017; Chan et al,

2020). However, saliva is chosen over nasopharyngeal or oropharyngeal specimens to monitor serial viral load. Because CoV cannot be detected in nasopharyngeal aspirate of many samples, saliva is considered a promising non-invasive specimen, by which patient discomfort and health hazards to healthcare workers is reduced during repeated sampling. Consequently, early diagnosis and isolation of cases, which can be strategic for infection, control (K. K.-W. To et al, 2020). Nevertheless, nasopharyngeal and oropharyngeal specimen collection causes discomfort and may cause bleeding, especially in patients with thrombocytopenia (Chan et al, 2020). Hence, they are not desirable for serial monitoring of viral load. Moreover, recently K.To, Yip, et al. approved that saliva collection requires about half time and cost than that required for nasopharyngeal aspirate collection (K. To, Yip, et al, 2019). On the other hand, Sabino-Silva et al, suggested possibility of at least one of three different pathways for COVID19 to present in saliva: first, by COVID19 carrying fluid exchanged between the upper and lower respiratory tract with oral cavity. Second, when COVID19 present in the blood can enter mouth via crevicular fluid with serum-derived proteins content (Chan et al, 2020). Last, may be thorough major-and minor-salivary gland ducts involved with COVID19 infection that subsequently release particles in to the saliva (Liu et al, 2011). Thus, saliva plays an essential role for both diagnosis and transmission of infection (Sabino-Silva et al, 2020).

Transmission routes and prevention:

Prevention of COVID-19 infection seems to be, somehow, challenging as asymptomatic carrier transmission has been documented, (Chan et al, 2020; Rothe et al, 2020) even with normal chest Computed Tomography (Bai et al, 2020). Added to, atypical early stage symptoms in some patients infected with the virus that may be related to the rapid spread of the infection (Wang et al, 2020). Recently, studies confirmed that person to person transmission of respiratory viruses, (Guan et al., 2020; Qing et al, 2020) is certainly due to receptor recognition (Wan et al, 2020). This can occur directly or indirectly through large or fine droplets (Peng et al, 2020; Wei and Li, 2016). Coughing and speaking (Sabino-Silva et al, 2020) are possible routes through which sputum can be emitted. Therefore, COVID19 may be transmitted directly or indirectly via saliva (Wei and Li, 2016) even without coughing or other respiratory symptoms. Sneezing, on the other hand, might contribute to further surface contamination (K. K.-W. To et al, 2020; Yan et al, 2018). It is also suggested that droplets exhaled by mechanisms other than cough, are sources of infection wherein viral load has been detected in the fine-personal aerosol particles, which can be generated from normal healthy lungs by small airway closure and reopening (Fabian et al, 2011). Increased frequency of airway closure and reopening during respiratory infections could be due to inflammation, with a corresponding increase in aerosol generation and contagiousness (Edwards et al, 2004). Aerosols that spread out during medical procedures specifically in dental clinic could be another important route of COVID19 transmission, unless serious precautions are to be followed. In addition, it was observed that HCoV infectious capacity at room temperature ranges between 2h up to 9 days (Kampf et al, 2020), with a favorable persistence at higher levels of humidity. So, it is necessary to keep the dental office environment clean and dry in order to decrease the persistence of COVID19 (Peng et al, 2020). It is also important to consider transmission by contaminated blood. Consequently, patients suspected with COVID19 can be risky for dental and

oral surgical intervention, (Sabino-Silva et al, 2020) even those ordinary oral surgical procedures that do not require rotary armamentarium use, because the operator and staff are directly and closely exposed to airborne particles and patient personal aerosols containing this virus. (Wax and Christian, 2020). Until an effective vaccine is to be discovered, social distancing is the only and foremost method by which prevention is achieved. Hence, it is important to focus on the following points to continue safe dental work for both patient and health care workers:

First: limited exposure (on need exposure) through:

a. Online consultation or tele-dentistry which is facilitated by digital technology, and is applicable nowadays in almost all procedures related to dental treatment since it took place first in patients `dental and medical history records, wherein suspected COVID19 infection two features are required in the case presentation; fever and/or respiratory infection symptoms, added to the epidemiological association with the virus. (WHO, 2020) Clinical pictures may also be sent through tele-dentistry programs e.g. smile mate that can be helpful for diagnosis and follow up procedures, on the other hand, prosthodontic laboratory communication can be minimized with the CAD-CAM technology via sending digitally scanned impressions of high specific details, by which risk of exposure to contaminated prosthodontics impressions is reduced.

b. Replacement of conventional diagnostic intraoral radiographs with digital extraoral radiographs when applicable (Vandenberghe et al, 2010).

c. Improvement of patient` education and information about infection and prevention control measures via digital connection.

Second: oriented exposure by:

a. Following WHO recommendations that emphasize appropriate use of all personal protective equipment (PPE), including fit-tested N95 or FFP3 (Chughtai et al, 2013) masks, fluid repellent disposable gowns with long sleeves, gloves that covers the gown cuff and face shield. So, in case of being in doubt, dental emergency patients with febrile respiratory illness of unknown etiology should be managed with COVID19 (PPE) in accordance with guidelines considering contact, droplet and airborne (Wax and Christian, 2020). These recommendations require precise application and training of health care workers on donning and doffing procedures (WHO, 2020).

b. Environmental cleaning and disinfection of all surfaces with 0.1% sodium hypochlorite or 62-71% ethanol that significantly reduces coronavirus infectivity on surfaces within 1 min exposure time (Kampf et al, 2020).

c. Implementing adequate ventilation protocol especially between succeeding patients, (WHO, 2020) and airflow within hospital wards that can decrease the risk of nosocomial spread of some coronavirus strains. Wei and Li, 2016, were approaches similar to negative airflow ICU room that were applied during SARS CoV outbreak can be repeated at dental clinic and hospitals to manage the COVID19 outbreak.

d. Cautious performance of aerosol-generating procedures (AGP) (WHO, 2020) that can be achieved by:

1. Pre-operative 1 min mouth rinse with oxidative agent like 0.2% -1% povidone or 1% hydrogen peroxide, followed by conventional 0.2% chlorohexidine (CHX) or 0.05% to 0.1% cetylpyridinium chloride (CPC) to lower viral and microbial population in the oral cavity (Eggers et al, 2018; Izzetti et al, 2020; Peng et al, 2020).

2. Two handed dentistry with an angula-

tion of 30°-60° of both aerosol generating (AGP) source and high volume evacuator (HVE) as seen in figure 1, or even the use of extra oral suction system to allow proper suction, preferably with the use of universal barrier methods e.g. rubber dam (Avasth, 2018).

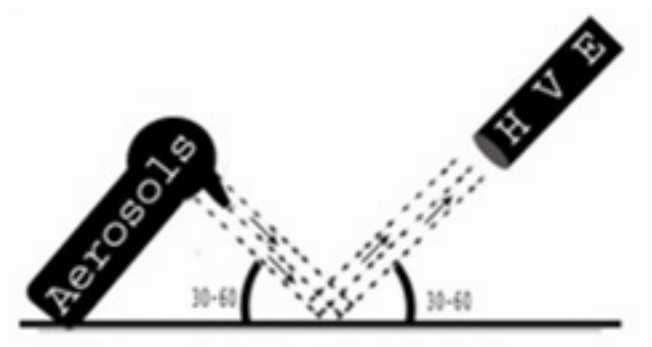

Figure (1): Showing the (30°-60°) angulation of the AGP source and HVE.

3. Maintaining proper physical patient-operator distance and posture via keeping hind position and directing patients face away from the operator especially during AGP. It is also important to avoid close unprotected exposure to symptomatic individuals.

4. A controversial use of powered air purifying respirators (PAPRs) instead of N95 masks during these procedures is also present (Wax and Christian, 2020).

Third: decreased time of exposure through:

a. Decreasing waiting room time of the patient depending on the medical and dental history obtained via scheduled appointment utilizing digital technology.

b. Lasers application which is one of the most effective methods used in different dental and oral surgical procedures with many advantages among which; decreased intraoperative time, lower pain and discomfort proprioception, added to bloodless field and decreased trauma to the surrounding tissue with precise cut, (Parker, 2007) that might provide a promising solution through such conditions. The most commonly used diode lasers, for instance, are known of different wavelengths specific to target pigments like hemoglobin and melanin in the soft tissues. It penetrates to a depth less than that of Nd: YAG. This permits greater operator control and reduces lateral thermal damage. Thus, it becomes popular to treat peri-implantitis due to bactericidal effect that do not induce implant surface changes. Other uses of diode lasers may include; gingival melanin depigmentation, Fordyce granule excision, gingival hyperplastic lesions removal and management of Hemangioma. A carbon dioxide (CO_2) laser are comparable to diodes by reduced thermal damage for the same reason, and is exceptionally efficient for soft tissue vaporization, due to high absorption in water, collagen, and hydroxyapatite. Additionally, they are efficient as a strong hemostatic and bactericidal technique with minimal wound contraction and consequently minimum scarring. Other types of lasers are the Erbium family that are preferable for hard tissue and bone surgical procedures (Asnaashari and Zadsirjan, 2014; Convissar, 2015). Nevertheless, laser plume is one of the side effects of some types of lasers (Garden et al, 2002) that can be restricted via (PPE) and HVE use.

c. Applying digital dentistry simulation like CAD-CAM and medical facial camera system that offer both limited and decreased time of exposure, as less frequent dental clinic visits are required with decreased dental chair time. A study done by Mühlemann et al, considered that laboratory work was more time efficient when applying digital workflow than conventional methods, regardless the CAD-CAM system. In contrary, they considered full-arch conventional impression consumes less time objectively and favoured by both clinicians and participants over digital scanning (Mühlemann et al, 2019). Meanwhile,

when medical and dental history as well as preliminary diagnosis is achieved with teledentistry, chair side time can be reduced consequently (Sailer et al, 2019). On the other hand considered the novel medical facial camera system as a clinically acceptable and reliable means to simulate and measure 3D facial geometry, despite inconsistency in measurements of few particular facial landmarks which can be avoided via manual calibration before digital measurement is done (Liu et al, 2019). In conclusion, the COVID19 outbreak rings the bell to apply protective measures at dental/oral and other health professional levels, which must always be rigorous against the spread of infectious disease; it also offers saliva as a non-invasive diagnostic means (Sabino-Silva et al, 2020). Moreover, health-care workers should be monitored for onset of fever and respiratory symptoms. Once an entity is suspected, respiratory specimens should be tested immediately. In addition to serum antibodies that should be tested before and after their exposure to COVID19 to identify asymptomatic infections (Huang et al, 2020) because clinically asymptomatic patients may represent an 'occult' source of respiratory viruses for nosocomial outbreaks; therefore, they should be included in outbreak investigations (K. To et al, 2019). Further investigation, is required to rule out other possible routes of transmission (Zhou et al, 2020). Careful surveillance is also necessary to monitor the viral future host adaption, and evolution (Huang et al, 2020). Finally, prolonged shedding of COVID19 after recovery raises concern about its infectivity, transmissibility and pathogenicity (Rothe et al, 2020). So, in order to continue protected dental and oral surgical work, recent technologies can be beneficial and it is important to improve and generalize these elements to be cost effective for both patient and dental work team.

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