

Review Article

COVID-19 and Oral Health: An Insight

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ABSTRACT

COVID-19 has become an unprecedented health challenge globally. Research efforts are going at war foot to unravel the unpredictable nature and behavior of *SARS CoV-2* virus. The scientific community has succeeded to decipher the origin, pathogenesis, manifestations, and complications of COVID-19. The link between the oral cavity and COVID-19 has intrigued many as several studies have linked poor oral hygiene status to respiratory viral infections. A possible association between the inflammatory conditions of the oral cavity, increased viral load, superadded bacterial infections and increased complications in COVID-19 patients has been speculated. Many hypotheses have been proposed to logically explain the transmission of the virus from the oral cavity to the lungs via conducting airways or blood. And also, it is observed that improving the oral hygiene by standardized measures reduces the viral load in the oral cavity of COVID-19 patients, thus, improving overall health.

This review is an attempt to highlight and discuss the available literature regarding oral microbiome and COVID-19. It is advocated that simple oral hygiene practices could help to lower the risk of transmission of the *SARS CoV-2* virus from the mouth to the lungs, thus reducing the severity of symptoms and complications.

Keywords: Complications, Oral health, Oral microbiome, Pandemic, Transmission.

INTRODUCTION

COVID-19 caused by a novel human coronavirus, *SARS-CoV-2* has quickly developed into a global pandemic crippling the health infrastructures and economies worldwide.¹ The scientific community globally has deciphered the pathogenesis, associated risk factors, and

complications associated with the infection.² But, with the emergence of new variants, the dynamics of *SARS CoV-2* infectivity, transmissibility and clinical intricacies of multiple COVID-19 phenotypes pose a challenge.³ Genome sequencing of the *SARS CoV-2* has made it possible to understand the unpredictable nature of this virus but still many queries are unanswered and research is going on globally to unravel many mysteries.⁴ Few researchers have proposed that an association exist between COVID-19 and oral health status, but the concept is still under investigation.⁵ The oral cavity with its various niches is a remarkably intricate habitat which nurtures numerous microorganisms including bacteria, fungi, viruses, and protozoa.⁶ One of the major ecological burden that incites dysbiotic ecosystem favouring complex pathogenic microbial communities in the mouth is poor oral hygiene.⁷ There are certain systemic conditions that are influenced, either coincidentally or causally, by oral health status like diabetes, atherosclerotic disease, pulmonary disease, pregnancy, birth weight, osteoporosis, and kidney disease. In addition, an alteration in the biofilms composition has been found in individuals with most of these diseases.⁸

Although, the hypothetical cause and effect relationship between COVID-19 and oral microbiome has been proposed by researchers but still the evidence is insufficient. Thus, this paper intends to explore a plausible relationship between COVID-19 and poor oral hygiene status.

Oral cavity as transmission route of *SARS CoV-2*

The viral transmission underlying the current COVID-19 pandemic has been a matter of intense investigation. The mode of transmission of *SARS CoV-2* is via respiratory droplets and aerosols from infected person. The target receptors for the inhaled *SARS CoV-2* virus, i.e,

angiotensin-converting enzyme 2 (ACE2) and transmembrane protease serine 2 (TMPRSS2) are present in nasal epithelial cells and other sites where the virus binds and replicates.⁹ Vigorous innate immune response is triggered as the virus travels down the respiratory tract along the airway passage.¹⁰ Researchers have explored the involvement of the oral cavity in COVID-19 pathogenesis and transmission. It has been suggested that oral cavity could act as an incubator and a possible route for the spread of SARS-CoV-2 virus (Figure).¹¹ A study proved that epithelial cells in saliva could be the potential route for the spread of virus as variable expression of target receptors ACE2 and TMPRSS2 is seen in mucosal cells and salivary glands of the oral cavity and virus multiplies there robustly.¹² Therefore, one of the potential routes for the virus to spread to other parts of the body through the saliva could be the shed epithelium cells. Another way could be direct transmission to the lungs or digestive system via infectious saliva.¹³

According to a new research in patients suffering from gum disease, the virus can enroute affected individual's lungs by moving directly from mouth through saliva to bloodstream. In COVID-19 lung disease, the blood vessels of the lungs rather than airways, are affected initially.¹⁴ This new model of research is based on the oral cavity being a breeding niche for the virus to flourish and facilitating the virus to enter the bloodstream with any breach in oral immune defences.¹⁵ From gingival vasculature, the virus

can traverse through neck and chest veins reaching the heart and then into pulmonary arteries and small vessels in the lungs. This model may help us comprehend why some individuals develop COVID-19 lung disease and others do not.¹⁶

Oral health and COVID-19: A bipartite relationship

The manifestations of COVID-19 vary from asymptomatic illness, mild flu-like symptoms, breathing difficulties to severe pneumonia further progressing to adult respiratory distress syndrome (ARDS).¹⁷ The mortality rate of SARS-CoV-2 infection differs significantly worldwide.¹⁸ High risk population include older people and patients with comorbidities such as cardiovascular diseases, pulmonary diseases, hypertension, diabetes, and cancer.¹⁹ According to the literature, one of the substantiated fact is that a predisposition to bacterial super infections is common for patients suffering from respiratory viral infections contributing to more severe symptoms and mortality.²⁰ There is published literature available regarding bacterial super infections impacting the severity of respiratory disease and leading to more death in influenza pandemic in 1918 and 2009 (H1N1 influenza pandemic) where the primary cause of death was not from the virus itself.²¹ Zhou et al²² in a retrospective study observed that secondary bacterial infections were seen in 50% of patients with COVID-19 who have died whereas Chen et al²³ have found both bacterial and fungal co-infections.

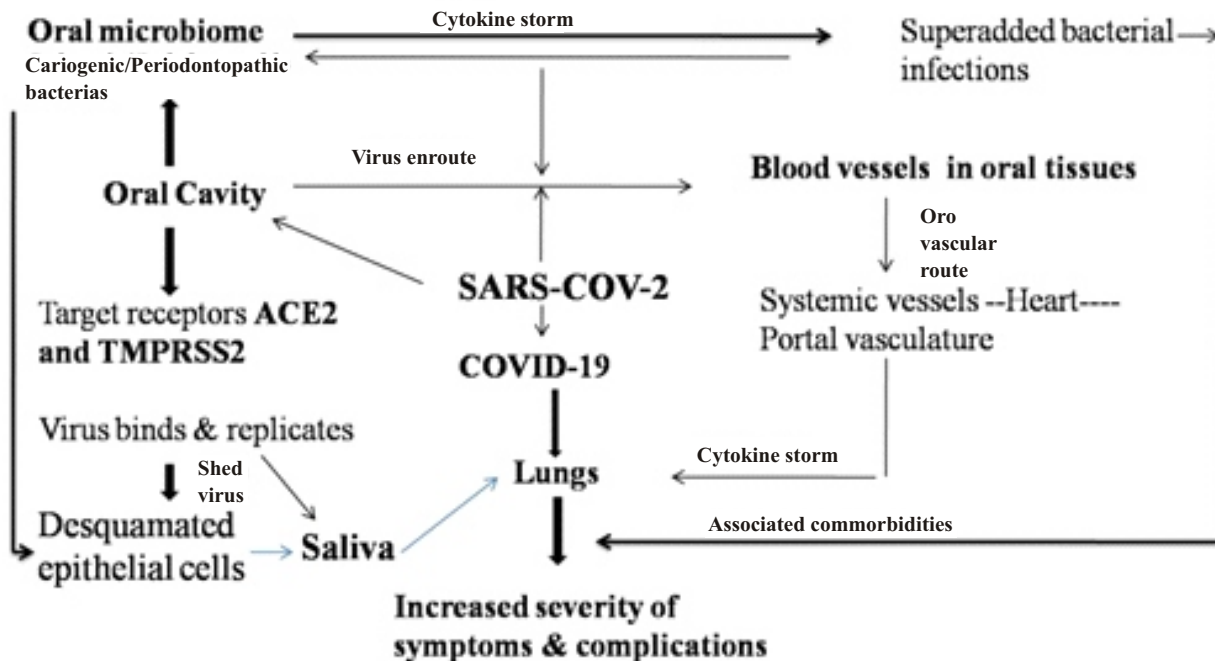


Figure: Oral cavity-COVID nexus.

Mild symptoms are seen in 80% of COVID-19 cases and in 20% cases increased severity of the symptoms is influenced by many host and viral factors.¹⁰ It has been suggested that plaque accumulation and periodontal inflammation further aggravate the possibility of the *SARS CoV-2* virus reaching the lungs and causing more severe cases of the infection.²⁴ One proposed theoretical concept is that the increased bacterial load due to dental problems and already increased inflammatory markers could possibly influence the course of the disease and its severity. In such cases decreased lymphocyte counts and increased neutrophil counts are suggestive of bacterial super-infections.²⁵

High loads of cariogenic and periodontopathic bacteria has been reported in the metagenomic analyses of patients suffering from corona virus disease thus endorsing the concept of a possible link between the oral microbiome and COVID-19 complications.²⁶ The association between the periodontopathic bacteria and chronic inflammatory systemic diseases including type 2 diabetes, hypertension, chronic lung disease, and cardiovascular disease is not new and such patients are also at high risk for severe COVID-19 symptoms, complications and death.²⁷ Overproduction of inflammatory cytokines which could be aggravated by poor oral health status might also be associated with “cytokine storm” seen in COVID-19 patients with worsened symptoms.²⁸

DISCUSSION

Kamel et al²⁹ found a significant inverse correlation between oral health and COVID-19 severity, values of C-reactive protein (CRP) and delayed recovery period. They inferred that severity of COVID-19 illness is affected by oral health status of the patients. In another study conducted in Qatar, comparison was drawn between COVID-19 patients who had severe complications including (assisted ventilation, admission to intensive care and death) and those without severe complications. It was concluded that patients with periodontitis were three times more likely to have severe COVID-19 complications. It was found that such patients also had increased levels of biomarkers (including white blood cell levels, D-dimer, and C-reactive protein) associated with worse COVID-19 outcomes.³⁰ Sampson et al²⁵ investigated the association between increased oral cavity bacterial load and COVID-19 complications. It was inferred that poor oral hygiene can increase the risk of respiratory infections and potentially post-viral bacterial complications. Sirin and

Ozcelik (2020)³¹ found a remarkable relationship between DD stage (Dental Damage Stage) and the severity and prognosis of COVID-19. Varadarajan et al³² stated that oral cavity diseases like dental caries, periodontitis, periapical pathologies and infection can predispose the patients to COVID-19 by facilitating viral entry. Gomes et al³³ observed that *SARS-CoV-2* RNA is harbored in the dental biofilms of symptomatic COVID-19 patients, thus supporting the concept that the oral cavity can be a potential source of viral infection.

Kheur et al³⁴ presumed that *SARS CoV-2* can be detected in gingival crevicular fluid. Molayem and Pontes observed that in periodontitis patients, raised levels of cytokines particularly IL-6, can potentially increase the risk for COVID-19 pulmonary complications. Thus, the importance of oral hygiene and periodontal health for respiratory conditions and COVID-19 infections are interrelated.³⁵ Herrera et al³⁶ stated that decrease in the severity of the COVID-19 symptoms is related to reduced oral viral load of *SARS CoV-2*. It has been postulated that good oral hygiene habits can reduce the viral load.³⁷ Literature supports the link between *SARS CoV-2*, oral cavity and inflammatory oral conditions. There is a need to develop interventional and therapeutic strategies to disrupt viral load in the oral cavity which can potentially prevent virus passage to the lungs or blood.

CONCLUSION

The recent research supports the hypothesis that oral microflora impacts the severity of symptoms in COVID-19 patients. The data available is sparse and needs to be further substantiated by further clinical trials and studies. The characterization of co-infections in COVID-19 and the potential connection between the role of the oral microbiome and the course of infection also needs to be explored. This would facilitate simple and effective measures to maintain oral hygiene and reduce plaque accumulation to combat the virus.

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