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Can periodontal pockets and caries lesions act as reservoirs for coronavirus?

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Abstract

The periodontal pocket and likely caries lesions may act as a reservoir and source of dissemination and development of systemic infections. While periodontal pockets have been found to harbor several viral species, there is no information on its ability to serve as a reservoir for the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). We have used a real-time polymerase chain reaction (RT-PCR) approach to evaluate SARS-CoV-2 in periodontal pockets and cavitated caries lesions in a cross-sectional study of 72 participants who were divided into six groups: symptomatic positive COVID-19 cases with periodontal pockets, symptomatic positive with cavitated caries lesions, asymptomatic positive with periodontal pockets, asymptomatic positive with cavitated caries lesions, positive control, and negative control. A total of 180 samples were interrogated by RT-PCR to amplify the SARS-CoV-2 E and S genes. SARS-CoV-2 was present in 41.7% of symptomatic positive COVID-19 cases with periodontal pockets and 16.7%

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SUPPORTING INFORMATION

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of symptomatic positive with cavitated caries lesions. The mean Ct value of E and S genes in periodontal pockets patients were 36.06±0.46 and 30.06±6.73, respectively, and the mean Ct value for both genes in caries lesions patients were 35.73±4.14, and 34.78±1.93, respectively. The sensitivity, specificity, and accuracy to detect SARS-CoV-2 among periodontal pockets were 20.8% (95% CI 7.13–42.15), 100% (95% CI 73.54–100.0), and 47.2% (95% CI 30.22–64.51), respectively. Among cavitated caries lesions patients, they were 8.3% (95% CI 1.03–27.0), 100% (95% CI 73.54–100.0), and 38.9% (95% CI 23.14–56.54), respectively. SARS-CoV-2 can be detected in periodontal pockets and caries lesions, and these sites may act as reservoirs for the virus. However, the sensitivity of SARS-CoV-2 detection is low compared with other methods. To our knowledge, this report is the first to investigate the relationship between SARS-CoV-2 and periodontal pockets and caries.

1 | INTRODUCTION

There are several viruses that have been detected in these pockets such as herpes simplex virus (HSV), Epstein–Barr virus (EBV), human papillomavirus (HPV), and human cytomegalovirus (HCMV) (Aggarwal et al., 2017; Cappuyns et al., 2005). Preliminary observations indicate the expression of the angiotensin converting enzyme-2 (ACE-2) in oral epithelial cells (Badran et al., 2020) and have raised the question of its ability to facilitate the periodontal pocket to serve as a reservoir for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

The periodontal pocket may act as a hospitable environment for viral infection and survival. There are several potential sources for viral infection in these pockets such as direct exposure of epithelial gingival tissue to the oral environment, or virus movement in the bloodstream or through infected immune cells in the periodontium (Miller, 2014). In the present study, we have used a real-time polymerase chain reaction (RT-PCR) approach to evaluate SARS-CoV-2 in periodontal pockets and cavitated caries lesions in a cross-sectional study of 72 participants. The observations presented in the report supports a hypothesis that the samples obtained from periodontal pockets or cavitated caries lesions will exhibit SARS-CoV-2 if it is present, and this might serve as an alternative means of virus detection comparable to the other methods such as nasopharyngeal swab, oropharyngeal swab, and saliva testing.

2 | MATERIALS AND METHODS

This is a cross-sectional study that took place at King Fahad General Hospital in Jeddah City, Saudi Arabia. This was study approved by the Institutional Review Board at Jeddah Health Affairs, Ministry of Health (#01352).

To be included in this study, participants were required to be at least 18 years of age and could not have received any previous COVID-19 treatment. In addition, they must receive a nasopharyngeal swab for SARS Cov-2 detection and did not use any mouth rinse. Then, patients were divided into six groups: symptomatic positive COVID-19 cases, asymptomatic positive COVID-19, or control with periodontal disease, or cavitated caries lesions.

An intraoral examination confirmed the presence of periodontal disease and caries lesions in each participant. For periodontal disease patients, four swabs were obtained from each patient using paper point. Each swab was taken from the deepest pocket in each quadrant. For cavitated caries lesions patients, a single swab was obtained from the cavitated lesion. Both samples (periodontal and caries) were delivered to the lab using a viral transport medium (Kang Jian Medical, China). RNA extraction was carried out and RT-PCR was performed using LabGun COVID-19 RT-PCR Kit.

Data were analyzed using SPSS Statistics version 25. A chi-square, Fisher's exact, or one-way analysis of variance was used to compare between the groups. p-Value < 0.05 was considered statistically significant. Moreover, sensitivity, specificity, negative predictive value, positive predictive value, and accuracy were calculated with a 95% confidence interval (CI).

3 | RESULTS

This is a pilot study of 72 patients. The average age of participants was 38.1. The majority were males (69.4%), had a bachelor's degree or higher (68.1%), and were nonsmokers (68.1%) (Table S1). In looking at tooth/site level, upper first premolar (27.0%) and lower first molar (25.0%) were the most commonly affected teeth in the symptomatic group. The asymptomatic group did not show any specific pattern (Table S2).

SARS-CoV-2 was present in 41.7% of symptomatic positive COVID-19 cases with periodontal pockets, and 16.7% of symptomatic positive with cavitated caries lesions cases (Table 1). In the sample level, the prevalence was 12.5% and 16.7%, respectively (Table 1). The mean *Ct* value of E and S genes at periodontal pockets was weak to moderate, 36.06 ± 0.46 and 30.06 ± 6.73, respectively. The mean *Ct* value for both genes at caries lesion patients was weak as well (Table 1). The positive SARS-CoV-2 at periodontal pockets or cavitated caries lesions did not show any specific characteristics compared with the overall sample (Table S3). The overall sensitivity, specificity, negative predictive value, positive predictive value, and accuracy to detect SARS-CoV-2 among periodontal pockets were 20.8% (95% CI 7.13–42.15), 100% (95% CI 73.54–100.0), 38.71% (95% CI 33.97%43.68–%), 100%, and 47.2% (95% CI 30.22–64.51), respectively, and among cavitated caries lesions were 8.3% (95% CI 1.03–27.0), 100% (95% CI 73.54–100.0), 35.29% (95% CI 32.59–38.10), 100.0%, and 38.9% (95% CI 23.14 −56.54), respectively.

4 | DISCUSSION

The preliminary observations from our study have shown the potential direct association between SARS-CoV-2 and oral tissues. To our knowledge, this is the first report to demonstrate the detect presence of SARS-CoV-2 in periodontal pockets and cavitated caries lesions. Several hypotheses were suggested which may explain the associations between SARS-CoV-2 and oral tissue. One hypothesis is that periodontopathic bacteria might exacerbate COVID-19 by initiating the expression of angiotensin-converting enzyme 2 (ACE-2), a receptor for virus infection, and inflammatory cytokines (Takahashi et al.,

2020). These receptors are present at the salivary gland duct and in alveolar epithelial cells in the lungs (Liu et al., 2011).

Cleaving the S glycoproteins by periodontopathic bacteria is another potential mechanism (Badran et al., 2020; Takahashi et al., 2020). Other investigators suggested that neutrophil extracellular trap production and Th17 might play a role in the pathogenesis of COVID-19 (Gupta & Sahni, 2020). Moreover, infected salivary gland is also can play role in these infections, especially in cavitated caries lesions (Gupta & Sahni, 2020; Liu et al., 2011; Wan et al., 2020).

The overall diagnostic sensitivity of SARS-CoV-2 in periodontal pockets and cavitated caries lesions is low compared with other methods such as nasopharyngeal swab, oropharyngeal swab, and saliva testing. It ranged between 79% with the oropharyngeal swabs to 85% with nasopharyngeal swabs and mouth rinse (Hitzenbichler et al., 2021).

5 | CONCLUSION

SARS-CoV-2 can be detected in periodontal pockets and caries lesions, and these sites may act as reservoirs for infection. However, the sensitivity of SARS-CoV-2 detection used in this study is low compared with other methods. Moreover, it is highly recommend for dental practices to take all standard precautions with all patients. Future studies should evaluate the relationship between saliva and in cases of SARS-CoV-2.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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DATA AVAILABILITY STATEMENT

Data can be made available by making reasonable request to the corresponding author.

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TABLE 1

Prevalence of SARS-CoV-2 at periodontal pockets and caviated caries lesion reported as sites or patients levels and comparison of the PCR cycle threshold (*Ct*) of E and S genes at caries lesion or periodontal disease

Genes tested	Group	Number of samples	Samples with SARS-CoV-2, N (%)	Number of patients	Patients with, SARS-CoV-2, N (%)	Maximum *Ct* value	Minimum *Ct* value	Mean ± SD
E gene								
	Symptomatic COVID-19 with caries lesion	12	2 (16.7)	12	2 (16.7)	38.65	32.80	35.73 ± 4.14
	Symptomatic COVID-19 with periodontal disease	48	6 (12.5)	12	5 (41.7)	36.47	35.54	36.06 ± 0.46
	Asymptomatic COVID-19 with caries lesion	12	0	12	0	–	–	–
	Asymptomatic COVID-19 with periodontal disease	48	0	12	0	–	–	–
	Control no COVID-19 with caries lesion	12	0	12	0	–	–	–
	Control no COVID-19 with periodontal disease	48	0	12	0	–	–	–
S gene								
	Symptomatic COVID-19 with caries lesion	12	2 (16.7)	12	2 (16.7)	36.93	33.41	35.17 ± 2.39
	Symptomatic COVID-19 with periodontal disease	48	6 (12.5)	12	5 (41.7)	36.46	23.10	30.62 ± 6.73
	Asymptomatic COVID-19 with caries lesion	12	0	12	0	–	–	–
	Asymptomatic COVID-19 with periodontal disease	48	0	12	0	–	–	–
	Control no COVID-19 with caries lesion	12	0	12	0	–	–	–
	Control no COVID-19 with periodontal disease	48	0	12	0	–	–	–