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Investigation of the Presence of SARS-CoV-2 in Aerosol After Dental Treatment

Hakan Akin [a*], *Oguz Karabay* [b], *Hande Toptan* [c], *Halit Furuncuoglu* [d], *Gurkan Kaya* [d], *Emine Gulsah Akin* [e], *Mehmet Koroglu* [c]

[a] *Department of Prosthodontics, Faculty of Dentistry, Sakarya University, Sakarya, Turkey*
[b] *Department of Infectious Diseases, Faculty of Medicine, Sakarya University, Sakarya, Turkey*
[c] *Department of Microbiology, Faculty of Medicine, Sakarya University, Sakarya, Turkey*
[d] *Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Sakarya University, Sakarya, Turkey*
[e] *Department of Restorative Dentistry, Faculty of Dentistry, Sakarya University, Sakarya, Turkey*

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ABSTRACT

Aims: The objective of the present study was to investigate the presence of SARS-CoV-2 in aerosol and COVID-19 contamination distance asssociated with ultrasonic scaling and tooth preparation.

Methods: Twenty-four patients with COVID-19 were included in this study. Removal of supragingival plaque with ultrasonic instruments for 10 minutes and high-speed air-turbine using for the simulation of cutting the maxillary right canine tooth with a round diamond bur for 5 minutes were performed. Patients were randomly assigned to 2 groups: In group A, medium-volume suction was used during treatment. In group B, high-volume suction with an aerosol cannula was added to medium-volume suction. Prior to treatment, 5 glass petri dishes containing viral transport medium were placed in the operating room. After treatment, petri dishes were immediately delivered to a microbiology laboratory for real-time polymerase chain reaction (RT-PCR) analysis.

Results: RT-PCR test results were negative for all specimens in group B. However, 5 positive test results for COVID-19 were detected in group A specimens.

Conclusions: Suction with an aerosol cannula is very important to prevent COVID-19 viral contamination via aerosol. In addition, a high-volume suction capacity (air volume) of 150 mm Hg or 325 L/min is sufficient for elimination of viral contamination. Thus, high-volume suction should be used during dental treatments in COVID-19 patients.

Introduction

In December 2019, a novel coronavirus was identified among patients with pneumonia in Wuhan city, Hubei Province, China. After rapid isolation of the virus, the discovery of a new coronavirus that had never been identified in humans before was declared, officially named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by the World Health Organisation on January 7, 2020.[1,2]

The respiratory disease deriving from SARS-CoV-2 infection was then named COVID-19.[1] COVID-19 has had an unprecedented impact on people across the world, and this outbreak quickly became a global public health crisis.[3,4] Spread of infection is mainly through aerosols, droplets (coughing, gagging, sneezing), and direct contact, which poses a risk to the oral and nasal mucosae and conjunctivae.[2,5] Self-collected saliva of most of 12 infected patients contained SARS-CoV-2 RNA. Therefore, COVID-19 transmission during dental procedures can happen through inhalation of aerosol/droplets from infected individuals or direct contact with mucous membranes, oral fluids, or contaminated instruments and surfaces.[5] During dental procedures, transmission should be of real concern in dental clinics. At present, there is only limited evidence of airborne transmission of viable virus via aerosol particles. Thus, the aim of the present study was to investigate the presence of SARS-CoV-2 in aerosol and COVID-19 contamination distance during ultrasonic scaling and tooth preparation. The first hypothesis of the

* *Corresponding author*. Sakarya University, Faculty of Dentistry, Department of Prosthodontics, 54100 Sakarya, Turkey.
E-mail address: drhknkn@hotmail.com (H. Akin).

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study was that SARS-CoV-2 would be detected in aerosol during ultrasonic scaling and tooth preparation with medium-volume suction in the clinical environment. The second hypothesis of the study was that there is no difference in aerosol contamination between medium- and high-volume suctions.

Methods

For this study, 24 patients (6 female and 18 male) with COVID-19 confirmed by real-time polymerase chain reaction (RT-PCR) who had been admitted to the Sakarya Provincial Health Directorate Sakarya University Training and Research Hospital were recruited. Patients underwent a baseline dental examination. Inclusion criteria was understanding of the study requirements and medical treatment taking place in the hospital. Participant exclusion criteria were age younger than 18 years, pregnancy, edentulousness, exhaustion, or difficulty walking. In addition, volunteer patients were asked to expectorate into a screw-cap plastic tube which contains viral transform medium and RT-PCR tests were performed on these samples in the plastic tube. The patients have negative results were not included in the present study. Treating patients with COVID-19 was difficult for patients and clinicians. Thus, a limited number of patients were included in the present study.

Written informed consent was obtained from all study participants before study entry. The Ethics Committee of Sakarya University and General Directorate of Health Services, Republic of Turkey Ministry of Health approved the study protocol (protocol number: 16214662/050.01.04/143), and the trial was conducted in accordance with the Declaration of Helsinki.

Five glass petri dishes with dimensions of 75 mm × 15 mm were sterilised for each patient and placed on the floor in a 12 m^2 operating room (2.9 m × 4.15 m). Each corner of the room received one petri dish, and the fifth dish was placed in the dental unit's cup holder (Stern Weber S200 Plus, Cefla Dental Group). The dental unit was set in the reclining position and the headrest had a ground clearance of 75 cm. This position was stored as position A in the dental unit, which is able to store different positions. Thus, all patients were treated in the same position (Figure).

Three milliliters of viral transport medium, which comes in a screw-cap plastic tube, were poured into each glass petri dish.

Two clinicians (HA and GK) with over 10 years of clinical experience performed treatment protocol for all patients. In addition, operations were assisted by the other 2 experienced

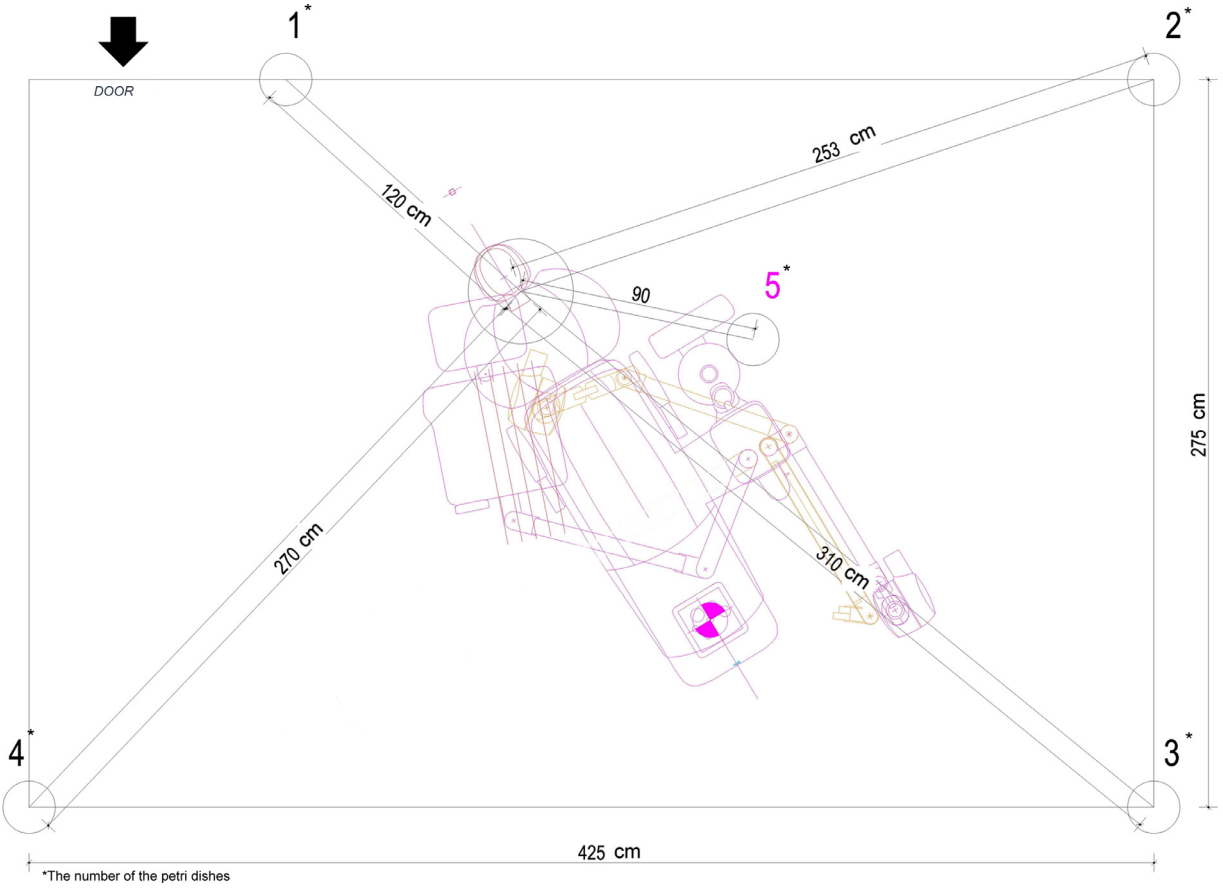

Figure – A schematic diagram of operating room, treatment position of the dental unit, and petri dishes positions.

clinicians (EGA and HF). The treatment protocol consisted of 2 sessions. Removal of supragingival plaque was the first session, performed with ultrasonic instruments (SC-A3, Cefla Dental Group). A 40,000-cycle per second (Hz) ultrasonic scaler was set at maximum power for all trials. The coolant volume of the ultrasonic scaler was adjusted to 50 mL/min, a volume reported as ideal for clinical use. Treatment time was standardised at 10 minutes. The second session consisted of use of a high-speed air-turbine (Slent Power Evo 4LK, Cefla Dental Group). Immediately following scaling, a simulation of cutting of the maxillary right canine tooth with a round diamond bur was performed. It was ensured that the bur did not touch the teeth. Second sessions lasted 5 minutes. Water cooling was adjusted to 15 mL/min, and the aerator was set at maximum power for all trials.

Patients were randomly assigned to 2 groups: In group A, medium-volume suction was used during treatments. In group B, high-volume suction with an aerosol cannula

Table 1 – Background information for the 24 patients involved in this study.

Patient	Age, y	Sex	Symptoms	Date of diagnosis/date of the dental treatment	CT values of PCR test (diagnosis)
1	29	Male	Fever, cough	09.06.2020 10.06.2020	19.08
2	29	Male	Fever, weakness	08.06.2020 10.06.2020	18.79
3	30	Male	Fever, headache	08.06.2020 11.06.2020	25.61
4	42	Male	Difficulty breathing, fever, back pain	08.06.2020 11.06.2020	32.54
5	50	Male	Cough, weakness	17.07.2020 20.07.2020	31.9
6	64	Male	Cough weakness	17.07.2020 20.07.2020	29.57
7	21	Male	Fever, weakness	06.08.2020 06.08.2020	23.92
8	57	Male	Fever, cough, palpitation, diarrhoea	09.08.2020 11.08.2020	19.05
9	48	Female	Fever, cough	31.07.2020 02.08.2020	22.13
10	51	Female	Fever, cough, loss of smell	28.07.2020 02.08.2020	27.4
11	52	Female	Cough, weakness	29.07.2020 01.08.2020	26.06
12	55	Male	Cough, weakness, loss of smell	05.08.2020 06.08.2020	32.51
13	42	Male	Cough	10.08.2020 11.08.2020	24.93
14	54	Male	Fever, cough	31.07.2020 01.08.2020	18.56
15	65	Male	Fever, cough, joint pain	07.08.2020 10.08.2020	23.92
16	29	Male	Fever, cough	27.08.2020 29.08.2020	12.52
17	62	Male	Muscle pain, joint pain	03.08.2020 04.08.2020	17.38
18	63	Male	Difficulty breathing	27.08.2020 01.09.2020	22.12
19	56	Female	Cough, weakness, difficulty breathing	04.09.2020 08.09.2020	24.22
20	40	Female	Cough, nausea,	09.09.2020 10.09.2020	20.88
21	49	Male	Cough, difficulty in breathing	10.09.2020 12.09.2020	28.23
22	64	Female	Cough, difficulty in breathing, weakness, inappetence	09.09.2020 12.09.2020	24.91
23	75	Male	Cough	12.09.2020 13.09.2020	25.66
24	70	Male	Fever	22.09.2020 23.09.2020	18.57

CT, cycle treshold; PCR, polymerase chain reaction.

Table 2 – The results of PCR test for the samples in the two groups.

	Negative		Positive		
	Group A	Group B	Group A*		Group B
Number 1	11	12	1	31.63**	-
Number 2	10	12	2	24.4**	-
				21.6**	
Number 3	11	12	1	22.4**	-
Number 4	12	12	-		-
Number 5	10	12	2	31.02**	-
				19.4**	

* Positive results were seen in 5 patients.
** Cycle treshold values of polymerase chain reaction test.

(1.5 cm diameter and 12 cm height) was used along with medium-volume suction. Dürr Vs1200 suction system (Dürr Dental SE; max unimpeded flow rate 2400 L/min, auxiliary air valve setting −170 mbar/hPa, max fluid rate of flow 24 L/min) was used. In addition, the suction machine was at a distance of 19 m from the dental unit. Furthermore, two flowmeters (Cattani 59168 and Cattani 040840, Cattani) were used to determine the suction capacity of the medium- and high-volume suctions. Medium-volume suction had a suction capacity of 80 mm Hg and 158 L/min (air volume), whereas high-volume suction had 150 mm Hg and 325 L/min suction capacity (air volume).

All clinicians wore masks (Type 7502, 3M) and safety glasses at all times during the treatments. Furthermore, sterile surgery uniforms and hair bonnets were used.

When each operation was finished, the clinicians and patient left the operating room to allow the deposition of droplets and aerosols. After 30 minutes, viral transport medium was transferred from the petri dishes to screw-cap plastic tubes using a sterile syringe. For each patient, 5 specimens were obtained. Specimens were immediately delivered to the microbiology laboratory and stored at 2 to 8 °C. Specimens were taken to a negative-pressure room in a Class 2-a biosafety cabinet. They were then vortexed for at least 5 seconds. Afterwards, RNA isolation was performed using the EZ1 Virus Mini Kit v2.0 in a Biorobot EZ1 (Qiagen, Germany) device. Elution of 60 μl of 400 μl sample was taken and used as a template in RT-PCR reaction. For RT-PCR study, a 10 μl master mix, 2 μl of primer, and 8 μl of RNA mixture were prepared per sample with a Genesis Real-Time PCR SARS-CoV-2 kit (Primer Design). Reactions were carried out at the following time and temperature, with total reaction volumes of 20 μl. At the end of each reaction, a cycle treshold value of less than 45 was interpreted as positive for SARS-CoV-2 RNA.

Data were recorded, and statistical analysis was performed using SPSS (Version 22.0). Relative risk tests were used to analyze the data with a 95% confidence interval.

Results

Background information for the 24 patients involved in this study was demonstrated in Table 1. Polymerase chain reaction (PCR) test results are presented in Table 2. According to the relative risk analysis, medium volume has negative effect on the PCR test results (0.917). PCR test results were negative for all specimens in group B. However, positive test results (8.3% according to relative risk analysis) were detected for 5 patients in group A. These were specimen numbers 1, 2 (twice), 3, and 5 (twice), whereas the specimens of number 4 exhibited no positive PCR test results for any patients (Table 2).

Discussion

SARS-CoV-2 RNA was detected in samples of group A. Thus, the first hypothesis that SARS-CoV-2 would be detected in aerosol during ultrasonic scaling and tooth preparation with medium-volume suction in the clinical environment was accepted. However, no SARS-CoV-2 RNA was detected in group B using the PCR testing. Therefore, the second hypothesis of the study was there is no difference in aerosol contamination between medium- and high-volume suctions was rejected.

In the dental literature, a limited number of studies have been performed regarding COVID-19 contamination during dental treatment. Ultrasonic scaling and cutting procedures with high-speed air-turbine were performed under water cooling. The present study is the first study in the dental literature to investigate possible SARS-CoV-2 contamination via aerosol.

On the other hand, Bennett et al.[6] demonstrated that aerosol peaks tended to decrease to background levels within 10 to 30 minutes, caused by rapid deposition of particles after aerosol generation at the patient head height. Consistent with this study, Veena et al.[7] found that the aerosol cloud could remain in the air up to 30 minutes after scaling. Thus, in the present study, 30 minutes passed before obtaining specimens from petri dishes to allow deposition of droplets and aerosols. In addition, some of the samples from group C demonstrated positive results in petri dishes 1, 2, and 3. These were far away from the source. Therefore, these results can only be explained by contamination from aerosols.

Furthermore, according to BS EN ISO 10637,[8] high-volume system has an air intake of more than 250 L/min at each cannula connector of the largest bore operating hose. In addition, Holliday et al.[9] used two different flow rates, 40 L/min low-volume suction and 159 L/min medium-volume suction. In the present study, 325 L/min high-volume suction and 158 L/min medium-volume suction was used.

Gloves, mask, and glasses are the main personal protective equipment used during dental treatment. However, there is resistance to the use of protective equipment in dental care. In 1990, the American Dental Association appealed to the courts against the mandatory use of protective equipment, claiming that no professional had contracted the disease.[5] In last 2 decades, knowledge about AIDS and now COVID-19 has pushed dentists to review safety standards. The American Dental Association and the US Centers for Disease Control and Prevention have recommended using high-volume suction during dental treatment to minimise dissemination of droplets, spatter, and aerosols.[10-12] Nevertheless, dentists have resisted this recommendation. The present

study demonststes the importance of high-volume suction for infection control during dental treatments.

In addition, based on the results of the present study, high-volume suction with an aerosol cannula is very important to prevent SARS-CoV-2 virus contamination via aerosol from patient to patient or from patient to clinician. Moreover, clinicians could mitigate the potential risk of the virus using UV air disinfection devices or HEPA-filter air cleaner devices in the operating rooms.

The limitation of the present study is that a few samples (5 in a room) were evaluated. The samples could be placed around the dental unit. In addition, clinicians' masks and safety glasses were not evaluated. On the other hand, the bur was not touched to the teeth when simulating the cutting teeth. Thus, high-energy particles were not produced. Moreover, during this study, only one dental unit was used. However, 9 additional dental units were attached to the same suction system. This study did not evaluate whether sufficient pressure can be supplied when all dental units are used simultaneously. In future studies, suction system capacity should be evaluated when all dental units are used at the same time.

Conclusions

Within the limitations of the study, high-volume suction with an aerosol cannula is very important to prevent COVID-19 viral contamination via aerosol. High-volume suction of 150 mm Hg or 325 L/min is sufficient to prevent COVID-19 contamination. Thus, high-volume suction should be used during dental treatment.

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Compliance with ethical standards

Ethical approval: The Ethics Committee of Sakarya University and General Directorate of Health Services, Republic of Turkey Minister of Health approved the study protocol (protocol number: 16214662/050.01.04/143), and the trial was conducted in accordance with the Declaration of Helsinki.

Informed consent: For this type of study, informed consent was not required.

Conflict of interest

None disclosed.

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