A clinical investigation of dental evacuation systems in reducing aerosols

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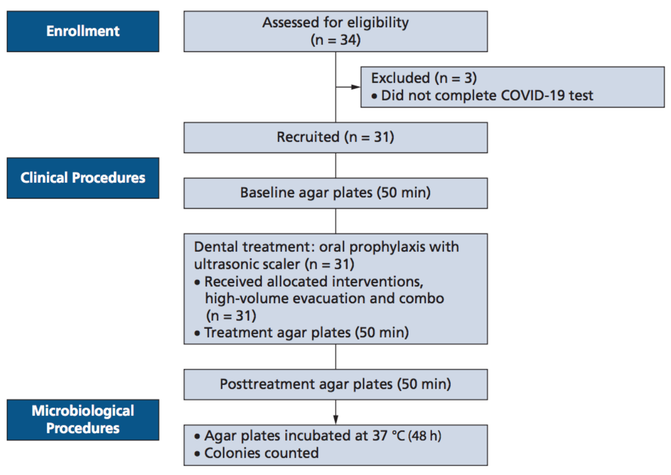
INTRODUCTION

The worldwide spread of severe acute respiratory syndrome coronavirus 2 has made it imperative for dentistry to implement safety precautions to reduce the spread while in a dental setting. This study, A clinical investigation of dental evacuation systems in reducing aerosols, by Suprano et al., was published in the Journal of the American Dental Association in June 2021. According to the Centers for Disease Control, aerosols generated during dental procedures using a high-speed handpiece or ultrasonic scaler may impose risks to health care personnel and patients. These aerosols that are generated may contain bacterial cells or spores, fungal spores, or viruses. The size of these pathogens generally ranges from 0.03 to 10µm for bacteria and 0.02 to 0.30µm for viruses. The SARS-CoV-2 size is in the range of 0.25 to 4µm, and it can remain viable in aerosols for up to 3 hours and up to days on some surfaces.
Dentistry utilizes many aerosol-generating instruments during necessary procedures, and control measures should be implemented to reduce the amount of aerosols. This study is a split-mouth controlled clinical trial aimed to evaluate the effectiveness off high-volume evacuation (HVE), combination (HVE and intraoral suction device) and posttreatment during dental prophylaxis with an ultrasonic scaler in a large clinic setting.

METHODS

Participants:
The participants were incoming third- and fourth-year predoctoral dental, second year international dental, and second-year dental hygiene students. The students performed the role as either an operator, assistant, or patient. 93 students were recruited via email and all had to pass the COVID-19 screening examination. The students acting as patients took a COVID-19 test as part of the criteria. The patients were in good general and oral health, negative COVID-19 test, and had at least 20 natural teeth present in the mouth. Exclusions included pregnant or nursing, allergy to suction device, tumor or significant pathology of soft or hard tissues of the oral cavity, presence of orthodontic bands, advanced periodontal disease, presence of a removable prosthesis, history of infectious disease or bloodborne diseases, and having had a dental prophylaxis within 2 weeks before the start of the study.

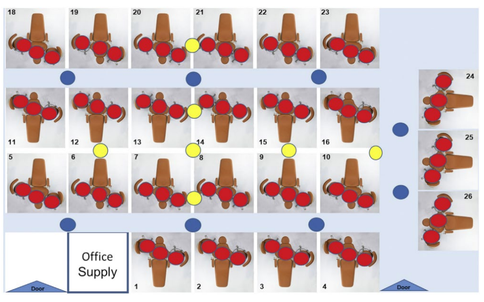
Clinical setting:
This study was a controlled trial using a split-mouth design in a large clinical setting with open bay cubicles with panels that were approximately 5 feet high. Each dental chair was equipped with hoses for a saliva ejector, high-volume evacuation (HVE) suction, and an air and water syringe. An additional HVE hose was used to connect the adjunct intraoral suction device (Mr. Thirsty).



PROCEDURES

Trypticase soy agar with 5% sheep blood plates were placed in various locations around the room:

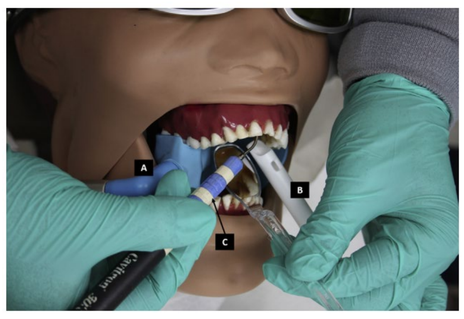
Zone 1: (operating zone): operator, assistant, patient. Attached to disposable bibs and placed at chest level (red)
Zone 2: mobile trays 2-4 feet horizontal distance (blue)
Zone 3: shelves or countertops >4 feet horizontal distance. (yellow)



Plates were placed at 4 treatment periods:

1. **Baseline**
2. **Using the HVE alone**
3. **Using the combination (HVE and intraoral suction device)**
4. **Posttreatment**

- For baseline levels (treatment period 1), plates were exposed to air for 50 minutes. The ultrasonic scalers were set to moderate level and to the highest output of water.
- For treatment period 2, assistants used the HVE only to reduce aerosols and remove accumulated saliva and debris for 20 minutes on 1 randomized side of the mouth. The procedure was then stopped, an additional 30 minutes was allotted for the aerosols to settle, and then the plates were collected.
- For treatment period 3, both the HVE and intraoral suction was used. The same treatment was performed on the other side of the mouth. After 20 minutes, the procedure was then stopped, an additional 30 minutes was allotted for the aerosols to settle, and then the plates were collected.
- For treatment period 4 (posttreatment), agar plates were placed for an additional 50 minutes.



ANALYSIS

To compare the mean CFUs between devices and baseline and posttreatment, Kruskal-Wallis and Wilcoxon signed rank tested were performed. A generalized estimating equation mixed effects analysis of variance model was used to estimate and test the treatment effect, time effect, and their interactions and adjusted for the correlations among observations for the split-mouth data.

RESULTS

The CFU levels for baseline and posttreatment periods were lower than both treatment periods, with HVE alone having the highest amount. When the treatment periods were compared with the baseline, there were highly significant differences for HVE and combination treatment periods (P<.001), and no significant different with the posttreatment period (p=.274). There was a statistically significant difference when comparing the treatment periods (P<.001).

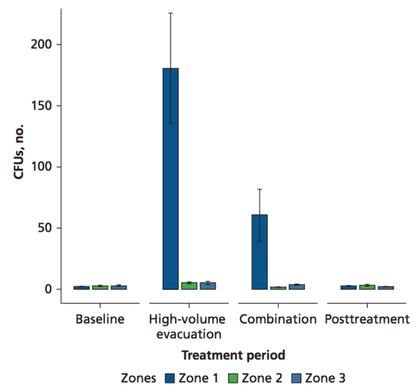


Table 1. Descriptive statistics showing means (standard deviations) of colony-forming units by treatment periods.

TREATMENT PERIOD	AGAR PLATES, NO.*	MEAN (STANDARD DEVIATION)
Baseline	124	2.26 (1.69)
High-Volume Evacuation	124	132.00 (353.00)
Combination (High-Volume Evacuation + Intraoral Suction Device)	124	46.10 (178.00)
Posttreatment	124	2.62 (2.23)

* Total number of 5% sheep blood agar plates.

Statistically significant differences within each zone for the HVE and combination treatment periods only. The highest amount of CFU's were found on the patients during the HVE treatment period, and the lowest amount of CFU's on the assistants.

Table 2. Pairwise comparisons of treatment periods.

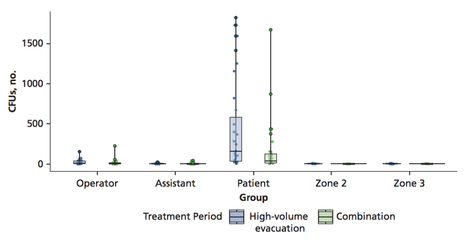
TREATMENT PERIOD	AGAR PLATES, NO.*	MEAN (STANDARD ERROR)	95% CI	*P* VALUE
Δ† HVE‡	124	117.00 (30.36)	56.90 to 177.10	< .001
Δ Combination (HVE + Intraoral Suction Device)	124	43.80 (15.94)	12.24 to 75.36	< .001
Δ Posttreatment	124	0.36 (0.22)	−0.08 to 0.80	.274
HVE Versus Combination	124	81.59 (35.27)	11.91 to 151.27	< .001

* Total number of 5% sheep blood agar plates. † Δ: Mean difference compared with baseline. ‡ HVE: High-volume evacuation.

Table 3. Mean colony-forming units in zones within treatment periods.*

	TREATMENT PERIODS							
	Baseline		High-Volume Evacuation		Combination		Posttreatment	
ZONE	Mean (SD†)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI
Zone 1								
Operator	2.68 (1.68)	1.95 to 3.41	26.16 (33.00)	19.45 to 32.87‡,§	18.84 (40.65)	13.24 to 24.44‡,§,¶	3.10 (2.49)	2.29 to 3.91
Assistant	1.61 (1.02)	1.32 to 1.90	6.68 (5.06)	5.19 to 8.17#	4.23 (7.95)	0.22 to 8.24¶,#	2.61 (1.99)	1.89 to 3.33
Patient	1.84 (1.68)	1.25 to 2.43	441.61 (569.17)	248.25 to 634.97‡,#,**	158.71 (331.55)	61.14 to 256.28‡,#,**	2.00 (1.63)	1.48 to 2.52
Zone 2	2.94 (1.65)	2.12 to 3.76	4.88 (2.96)	3.77 to 5.99§,**	1.94 (1.61)	1.47 to 2.41§,**	3.31 (3.28)	2.21 to 4.41
Zone 3	2.87 (2.26)	2.02 to 3.72	5.47 (3.58)	3.98 to 6.96**	3.00 (1.77)	2.68 to 3.32§,**	2.20 (1.61)	1.06 to 3.34

* Dwass-Steel-Critchlow-Fligner pairwise comparison was used to determine *P* values within treatment periods. † SD: Standard deviation. ‡ Statistically significant differences ($P < .001$) between operator and patient. § Statistically significant differences ($P < .05$) compared with zone 1, operator. ¶ Statistically significant differences ($P < .001$) between operator and assistant. # Statistically significant differences ($P < .001$) between assistant and patient. ** Statistically significant differences ($P < .001$) compared with zone 1, patient.



Highly significant difference when patient (zone 1) was compared with all other zones in the treatment periods.

Figure 5. Comparison of colony-forming units (CFUs) by treatment periods for zone 1 (horizontal distance, < 2.0 feet; vertical distance, ≈ 3.0 feet), zone 2 (horizontal distance, 2.0-4.0 feet; vertical distance, 3.0 feet), and zone 3 (horizontal distance, > 4.0 feet; vertical distance, 5.0 feet).

DISCUSSION

Many common dental procedures produce aerosols. As of now, there is no direct evidence that dental procedures are a major cause of airborne infections, however the risk must be minimized. Because the world is facing a global pandemic, it has raised concerns and awareness to control these aerosols. This is why it is imperative to identify effective measures that reduce the amount of aerosols generated during dental procedures.
HVE is standard for saliva control, and alone it can reduce aerosol and spatter. However, most dental practitioners do not use adjunct devices for suctioning due to decreased visualization and accessibility. The results of this study show that HVE alone may not suffice to reduce aerosols. Yet, most aerosols are confined to zone 1 in both treatment periods, and the highest amount of CFU's were found on patients and not the practitioner or assistant. These results are corroborated in different studies as well.
This study was done to evaluate 2 methods for controlling aerosol in a large clinic area with operators and assistants with limited clinical experience. The positioning of the plates provided a general idea of the microbial aerosols generated during a clinical setting, as well as to evaluate specific zones. The authors were surprised that low levels of CFU's were found in zones 2 and 3. This may be due to the positioning of the HVE, addition of the intraoral suction, the positions of the plates, and the airflow through the ventilation systems. The height of the plates may be a better explanation for the low levels of CFU's.
This study did not utilize nor evaluate the use of pre- and post-antibacterial mouth rinses, where other studies have reported a significant decrease in CFUs after dental procedures.

CONCLUSION

The combination of HVE plus an intraoral suction device significantly reduced the amount of microbial aerosol generated during the treatment periods.

REFERENCES

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