EVALUATION OF SPLATTER DISTRIBUTION OF IRRIGATION METHODS TO MINIMIZE SPREAD OF SARS-COV-2

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Introduction and Background

- **SARS-CoV-2** is a novel coronavirus that has recently caused a large strain on the healthcare system and has been declared the 6th international health crisis by the WHO.[1]
- **As of January 4, 2021**, SARS-CoV-2 has affected over **85 million** individuals and has claimed over **1.8 million lives**.[2]
- **Transmission** of SARS-CoV-2 is primarily through **aerosolized respiratory droplets**, direct contact with the virus, or fecal oral transmission (Figure 1).[3]
- Current methods to minimize SARS-CoV-2 transmission during dental procedures **including preoperative rinses with hydrogen peroxide, chlorohexidine, or povidone-iodine** solutions.[5]
- Procedures in Oral and Maxillofacial Surgery that utilize **rotary instrumentation with irrigation can aerosolize** the virus and increase operator and assistant exposure and subsequent infection (Figure 2).[4]
- **Novel irrigation systems** have been devised to reduce aerosol production and droplet splatter during procedures using rotary instrumentation when compared to aerosol production of assistant manual irrigation.
- Integration of H_2O_2 into irrigation solutions has been proposed to reduce oral dissemination of SARS-CoV-2.[5]

Figure 1

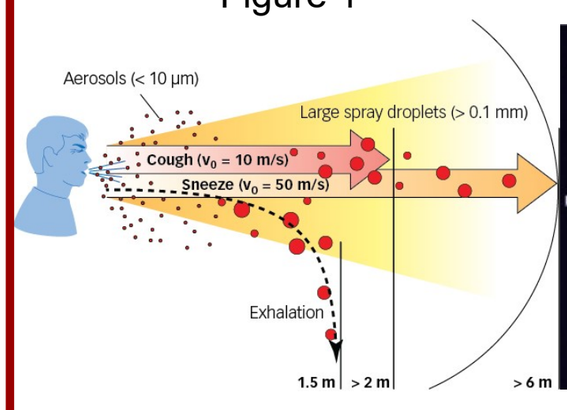


Figure 2

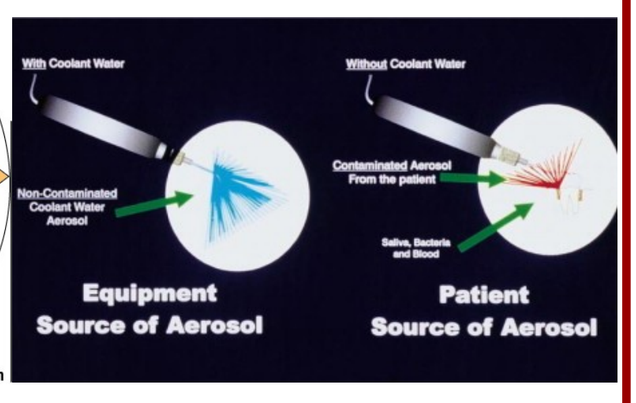


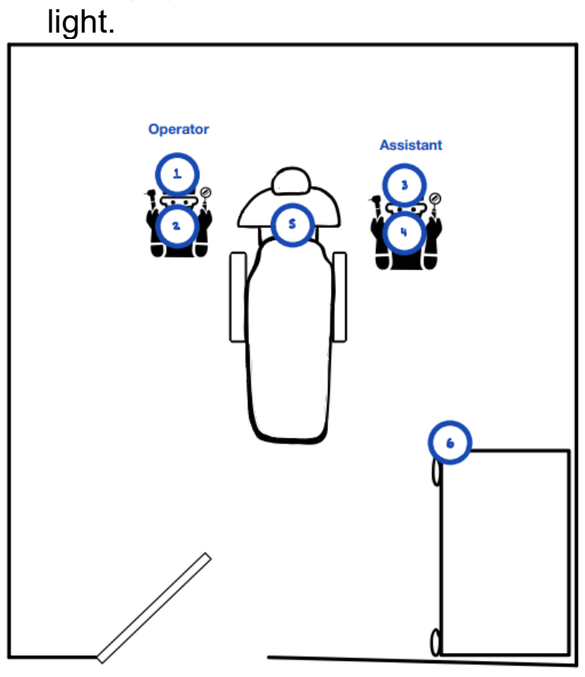
Figure 1: Diagram of SARS-CoV-2 via aerosolization of large spray droplets.
Figure 2: Diagram of aerosolization caused by rotary instrumentation in Oral and Maxillofacial Surgery (adapted from S. Froum DDS et. al, perioimplantadvisory.com)

Experimental Hypothesis

We *hypothesize* that the use of built-in irrigation systems will result in decreased splatter of aerosols and that admixing of H_2O_2 may result in an increased spread of droplets.

Materials and Methods

- Six (6), 142mm grade Whatman GF 92 filter papers were dispersed throughout the surroundings of the operatory in accordance with standard operator, assistant, and patient position, and a random control (Figure 3)
- Anatomical typodont in mannequin shroud was used to represent the live patient position and oral cavity (Figure 4)
- **Two irrigation fluids were utilized**, one composed of 3g fluorescein salt dissolved in 5 mL 0.9% of saline, 500 mL 1% H_2O_2 in 0.9% Saline and one composed of 3g fluorescein salt dissolved in 5 mL 0.9% of saline and 500 mL of 0.9% Saline.
- Simulation of surgical extraction of four third molars was simulated by running the surgical handpiece in each quadrant at 1 minute per quadrant, for **a total of 4 minutes per experimental procedure**.
- Each simulated procedure utilized **either an integrated handpiece irrigation or manual bulb irrigation** in conjunction with each of the irrigation solutions.
- **4 trials were completed:** Trial 1- Saline and Benair irrigation, Trial 2- H2O2 and Benair Irrigation, Trial 3-Saline and hand irrigation, Trial 4- H2O2 and Benair Irrigation
- Filter papers were collected after each procedure and imaged under UV light.



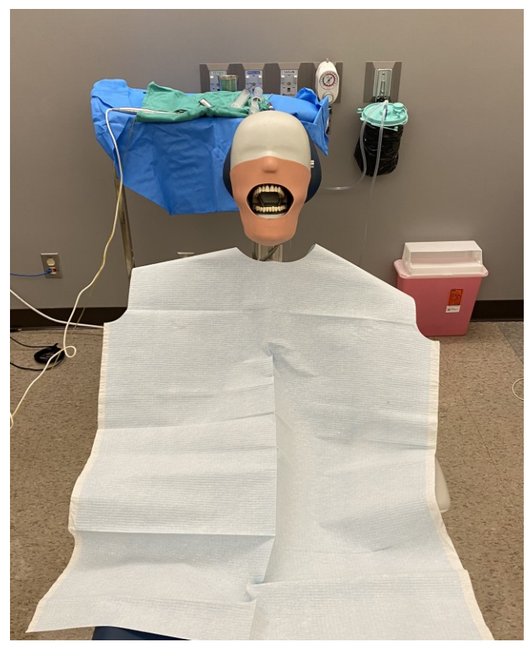


Figure 3: Diagram of the operatory setup and filter paper locations 1-6.
Figure 4: Image of the mannequin head and typodont positioned in the chair in the upright, extraction position that was

Analysis

- JPEG Images were analyzed using the ImageJ version 1.53 software
- Measurable area was selected for by isolating the filter paper area within the image
- % area of the contamination and mean area on the filter paper was primarily used for the statistical analysis in SPSS software.

Results

Table 1: Mean area of splatter in each evaluated site in pixels and mean %area as a ratio of splatter vs. area of filter paper.

Location	Mean Area	% Area
1. Operator Face Shield	76454.50	1.58
2. Operator Mask	71296.58	0.96
3. Assistant Face Shield	28632.50	0.59
4. Assistant Mask	13889.583	0.29
5. Patient Chest	1219225.75	25.56
6. Control	16274.50	0.34

Table 2: Combination of irrigation method and solution resulting in highest and lowest splatter area per site evaluated.

Location	Highest Spread	Lowest Spread
1. Operator Face Shield	**Saline, Benair Irrigation (x3)**	**H2O2, Benair Irrigation (x3)**
2. Operator Mask	Saline, Hand Irrigation (x3)	H2O2, Hand Irrigation (x3)
3. Assistant Face Shield	H2O2, Hand Irrigation (x3)	**H2O2, Benair Irrigation (x3)**
4. Assistant Mask	**Saline, Benair Irrigation (x3)**	**H2O2, Benair Irrigation (x3)**
5. Patient Chest	H2O2, Benair Irrigation (x3)	Saline, Benair Irrigation (x3)
6. Control	**Saline, Benair Irrigation (x3)**	H2O2, Hand Irrigation (x3)

Table 3: Statistical analysis of data using paired T-Test, pairing irrigation method with respective irrigating solution.

Pair	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	DF	Sig. (2-tailed)
Saline Area – H_2O_2 Area	10018.5	7690.88	3139.78	1947.42	18089.58	3.19	5	0.024
Saline %Area – H_2O_2 %Area	0.214	0.158	0.065	0.048311	0.38	3.32	5	0.021

Figure 5: Depicts the contamination of the operator face shield while using A. saline irrigation and B. H2O2 irrigation

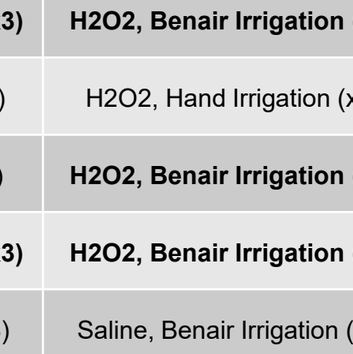


Figure 6: Depicts the contamination of location 6, the patient chest after treatment.

Discussion

- Used a pair-samples T-test to pair each saline experiment with its respective H_2O_2 counterpart
  - Assistant mask location showed a **significant difference between the saline and H2O2 groups (p<0.05)**, regardless of the use of Benair or hand irrigation.
  - The **H2O2 group shows smaller contaminated areas** and smaller contaminated percentages than the saline group.
- When comparing between the Benair and hand groups, there is no significant difference between any pairs.
- When analyzing the splatter by location, the patient chest was shown to have the highest mean contamination, followed by the operator face shield
  - Interestingly, both the provider face shield and mask demonstrated a greater mean than either of the assistants face shield or mask.
  - **This suggests that the face shield alone is not sufficient protection** for the operator in a surgical setting. Protective, fluid resistant masks and supplemental respirators are a critical supplement to the face shield.
- In comparing the % area of the filter paper covered in fluorescent splatter between trials 1-4 some notable observations were made
  - The **control location received higher %area in trials where the Benair irrigation was used**
  - This suggests that the use of irrigation line fed handpieces produces splatter that reaches a greater distance than irrigation provided externally to the handpiece.
- When examining the entire data set, using a linear regression model with all factors included, there is also no significance identified.
- This data was not statistically significant yet presents thought provoking information regarding transmission.

Future Directions

- Replicate the experiment 10-100 times to increase the statistical power.
- Use a camera without exposure adjustment to provide higher consistency with the images captured under UV light.
- Place more filters around the proximity of the operatory at other high touch locations.

References

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