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Evaluation Of Efficacy Of Extraoral Aerosol Suction In Reducing Aerosol Contamination During Oral Prophylaxis – An Exploratory Study

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Abstract:
Background*: Due to the frequent use of high-speed handpieces and ultrasonic scalers during dental procedures as well as the close proximity to patients' face to oral health care providers (dentists, dental hygienists, and dental assistants),there is a greater risk for disease transmission in dental clinic.. An ultrasonic scaler may leave behind minute aerosol droplets that could potentially carry infectious agents. By inhaling these particles while performing aerosol generating procedures, operators increase their risk of being infected. Therefore the aim of the present study is to evaluate the efficacy of extraoral suction in reducing aerosol contamination during oral prophylaxis.*
Materials and Methods*: A dental manikin with thermoplastic teeth was set up on a dental chair to simulate the patient and scaling procedure is carried out with citric acid solution placed in the water line of the dental chair. Oral prophylaxis procedure was performed in the presence of high volume evacuator with and without the usage of extraoral aerosol suction and the extent of contamination is assessed with litmus paper placed at several sites within the operatory and on various parts of the clinician and assistant. Chromatic colour change to red occurs on litmus paper when the splatter contacts the paper, therefore visually indicating contamination.*
Results*: The combination of HVE and EOS significantly reduced the aerosol spread in the operatory as well as over the clinician and assistant. Wrist was the most contaminated area of the body followed by face shield, chest and abdomen of both clinician and the assistant.*
Conclusion: *Extraoral aerosol suction device effectively reduced the dissemination of the aerosols and splatters generated during oral prophylaxis.*
Key Word*: Aerosol, extraoral suction, contamination, infection control, oral prophylaxis*

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I. Introduction

Clinical dentistry presents both dental professionals and patients at risk for exposure, mainly because dental treatments frequently produce airborne particles that are contaminated with bacteria, blood, viruses, and fungi(1). Droplets and aerosols from patient saliva and blood are produced during dental procedures that involve high-speed rotary handpieces, ultrasonic scalers for removing dental calculus, air-water syringes, and air polishers(2). This has been a persistent concern for the oral health care community and the COVID-19 pandemic raised concerns regarding cross contamination and infection control in the dental clinic.

Aerosols are a suspension of solid or liquid particles in a gas, with particle sizes generally ranging from 1 to 50 µm in diameter. Miller and colleagues defined splatter as airborne particles greater than 50 mm(3).

Dental professionals are currently looking for further strategies to reduce inhalable aerosol and splatter emission, minimise procedural hazards, and reduce exposure to oral health care professionals in light of the COVID-19 pandemic(4). Extraoral scavenger (EOS) devices, which have been proposed as an additional device that could lessen the spread of splatters and bioaerosols in the dental clinic, have become more widely available on the market since the start of the pandemic. Extraoral aerosol suction units are high airflow vacuum systems intended to scavenge aerosols and droplets from the vicinity of the patient's mouth and trap droplets by depth filtration for safe disposal(5). Therefore, the aim of the study is to evaluate the effectiveness of the Extraoral aerosol suction device in reducing the spread of aerosols during ultrasonic scaling.

II. Material And Methods

This in vitro experimental study was conducted in Department of periodontology at Government dental college and Hospital, Aurangabad in June 2021 to investigate the efficacy of extraoral suction in reducing aerosol contamination during oral prophylaxis.

Procedure methodology

The experiment was carried out in a dental operatory, using a dental manikin set up on a dental chair in reclined position. Full-mouth supragingival scaling was simulated with an ultrasonic scaler (Woodpecker UDS-P) at a maximum frequency (30 kHz) with water supplied from the dental chair.

Citric acid solution (10%) mixed with distilled water was placed in the water line of the dental chair. Universal indicator paper (UIP) was strategically placed at fixed labelled sites within the operatory and on various parts of the clinician and assistant. The Extraoral suction (EOS) unit (Steriliz Air plus - Confident) was used at maximum flow capacity throughout the procedure. The EOS intake was consistently placed in the 5 o'clock position, 10-15 centimeters from the oral cavity. Ultrasonic scaling was performed for about 10 minutes using the ultrasonic scaler, with simultaneous use of a high-volume evacuator (HVE) alone or combination of both HVE and EOS devices (HVE+EOS).

Group A – Use of High Volume Evacuator (HVE) alone

Group B – Use of both High Volume Evacuator and Extraoral aerosol suction (HVE+EOS)

UIP has a sensitivity range of pH 1–14, which chromatically changed to red on contact with citric acid solution, therefore visually indicating contamination. After the scaling was completed, the color change to red on the Universal Indicator paper was visualized and imaged under ultraviolet light. Then the images were analyzed using Image J software to analyze the area of the citric acid stain on litmus paper.

The surface area of contamination in the operatory was assessed by measuring the distance of aerosol spread from the oral cavity. Universal Indicator paper was placed at different sites over the operator and assistant, i.e on the wrist, face shield, chest, abdomen and in different sites in the dental chair, on the bracket table, chair light, patient drape and in the floor of the operatory.

Figure no 1 – Manikin set up on dental chair

Figure no 2 – Universal Indicator Paper

Figure no 3 – Extraoral aerosol suction

Figure no 4 – Oral prophylaxis performed using HVE AND EOS

Figure no 5 – UIP turning red on contamination with citric acid solution

Statistical analysis

All data were entered into a computer by giving coding system, proofed for entry errors. Data obtained was compiled on a MS Office Excel Sheet (v 2019, Microsoft Redmond Campus, Redmond, Washington, United States). Data was subjected to statistical analysis using Statistical package for social sciences (SPSS v 26.0, IBM). Differences between the two groups were analysed using the Mann-Whitney U test; statistical significance was set at $P<0.05$.

III. Results

On determining the extent of surface area of contamination between the two groups (Table no 1), the contamination was comparatively lesser in Group B when high volume evacuator in combination with extraoral aerosol suction was used, and at a distance of 45 centi meters away from the oral cavity, there was no contamination in Group B.

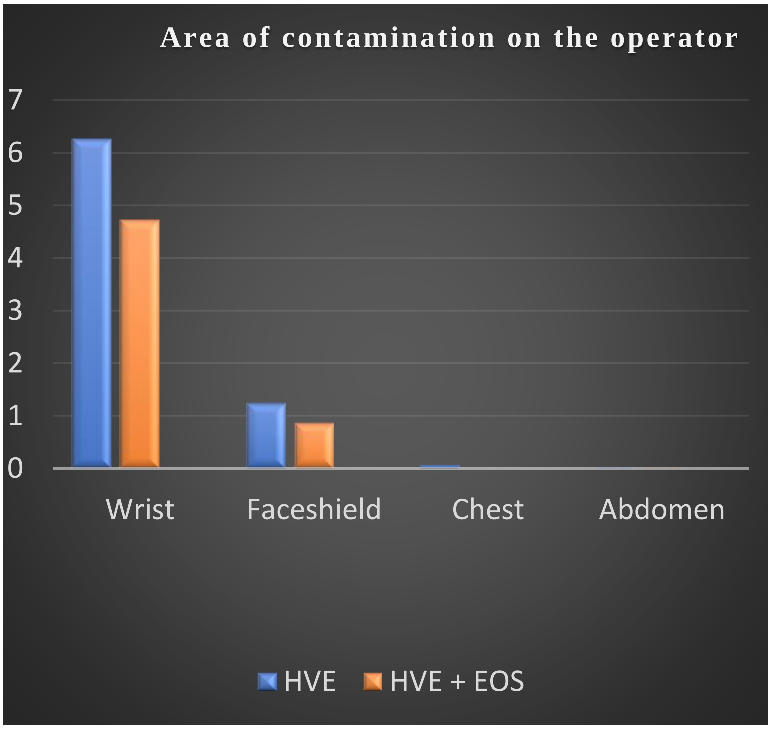
Table no 1 - The surface area of contamination regarding the distance from the oral cavity

DISTANCE	GROUPS	
	HVE (% surface area) Mean ± SD	HVE+EOS (% surface area) Mean ± SD
15 cm	2.537±0.256	1.842±0.102
30 cm	1.313±0.238	0.703±0.066
45 cm	0.024±0.010	0

When the extent of aerosol spread on the operator was assessed (Table no 2), the wrist of the operator was the most contaminated area in both the groups and the mean values were comparatively lesser in group B (4.726±1.649) than group A (6.268±0.729). Face shield was the next affected area followed by the operator's chest and abdomen. The mean scores of surface area of contamination were less in Group B (HVE+EOS) than group A (HVE alone) in all other sites including face shield, chest, abdomen on the operator.

Table no 2 - Area of contamination on the operator

Area of operator	Groups		p value
	HVE (% surface area) Mean ± SD	HVE+EOS (% surface area) Mean ± SD	
Wrist	6.268±0.729	4.726±1.649	0.013
Face shield	1.251±0.304	0.863±0.041	0.002
Chest	0.068±0.019	0.005±0.012	0.062
Abdomen	0.026±0.051	0.014±0.020	0.374

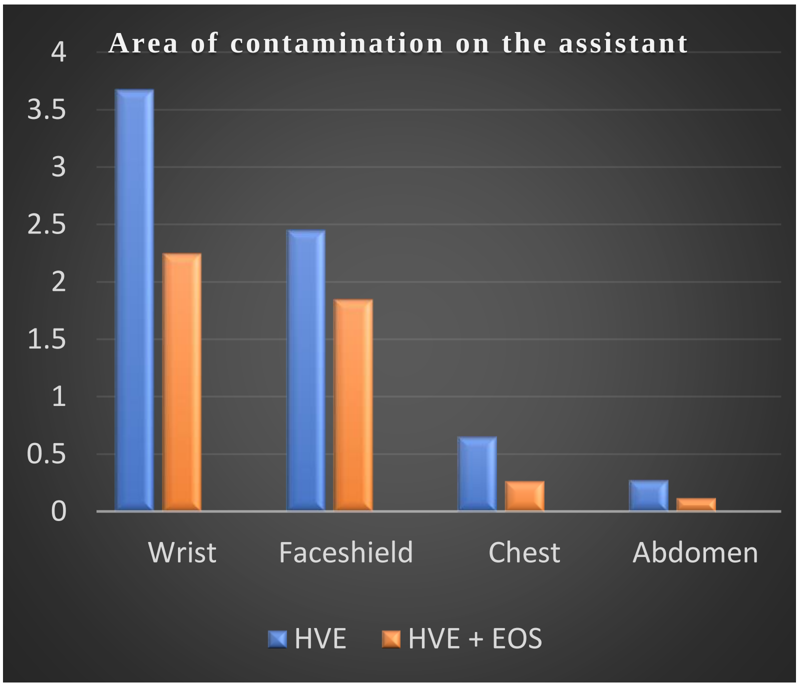


When the extent of aerosol spread on the assistant was assessed (Table no 3), the wrist of the assistant was the most contaminated area in both the groups and the mean values were comparatively lesser in group B (2.249±0.034) than group A (3.675±0.050). Face shield was the next affected area followed by the assistant's chest and abdomen. The mean scores of surface area of contamination were less in Group B (HVE+EOS) than group A (HVE alone) in all other sites including face shield, chest, abdomen on the assistant.

Table no 3 - Area of contamination on the assistant

Area of assistant	Groups		P value
	HVE (% surface area) Mean ± SD	HVE+EOS (% surface area) Mean ± SD	
Wrist	3.675±0.050	2.249±0.034	0.040
Face shield	2.450±1.023	1.846±0.524	0.051

Chest	0.652±0.241	0.264±0.092	0.010
Abdomen	0.271±0.275	0.115±0.068	0.326



IV. Discussion

Aerosol particles are smaller than 50 µm in diameter and remain airborne for long time. In pre-COVID-19 dental practice, attempts were made to minimize aerosol and droplet escape from the oral cavity using intraoral suction with low and high vacuum, tooth isolation with a rubber dam, use of mouth props with attached suction, and saliva drying agents, but respirable aerosols and droplet spatter were still dispersed with these methods in place. Extraoral suction units, negative pressure chambers, physical barriers, and Personal Protective Equipment (PPE) are some strategies for risk reduction(6). Many guidelines recommend that high-velocity suction, high efficiency particulate air (HEPA) filters and UV chambers in the ventilation system can reduce the potential risk of bioaerosol contamination.

The present study used the scaling procedure as a representative dental treatment because ultrasonic scaling has been demonstrated to produce the most aerosol and splatter contamination, suggesting a high risk for disease transmission in the dental clinic. In our study, maximum aerosol contamination was found in the assistant's zone followed by the operator zone. The arms, chest and surface of the face shield of both the operator and the assistant were found to be contaminated. Other surfaces that were contaminated other than clinician and assistant were bracket table, chair light and patient drape. This study suggested that secretions from the oral cavity could spread to 30–45 cm away from the mouth and that the left-hand side of the patient was the riskiest area for disease transmission. This was found in accordance with Veena et al (2014)(7) and Bentley et al (1994)(8), as the assistant zone was more affected in their studies.

An earlier study by Bennett et al (2000)(9) reported that the peak of aerosol concentration dissipates within 10 - 30 min with scaling procedures. Therefore, it is recommended that the operator should not remove the protective barrier immediately after the procedure to reduce the risk of contact with airborne contaminants. Patient screening, Personal protective equipment, such as long-sleeved medical gowns, gloves, masks, face shields, and shoe covers, proper infection control, and procedural isolation with intraoral techniques like rubber dam, as well as intraoral high-volume evacuation are still necessary to mitigate the risk of experiencing procedural contamination and transmission(10). The EOS reduced contaminated surface areas on every part of the assistant's and operator's bodies.

V. Conclusion

The use of HVE+EOS significantly reduced the contaminated surface area compared with the use of HVE alone. The contamination was detected on many parts of the body, especially on the chest, abdomen, and wrists of the operator and assistant, indicating a risk of disease transmission from patient to dental care professionals. The EOS device effectively reduced the dissemination of the bioaerosols and splatters generated during ultrasonic scaling. The combination of HVE and EOS is an effective method in preventing the transmission of airborne particles and could be used as a new strategy for infection control and management in the dental clinic.

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