# Efficacy of aerosol suction device when used along with a noval directional airflow

[1]Dr. Farooq Ahmad Wani, [2]Dr. Sabreena Azhar, [3]Dr. Amir Rashid Purra, [4]Dr. Fayaz Ahmed Ahnger, [5]Dr. Riyaz Farooq

[1]PG Scholar, Department of Conservative Dentistry, GDC & H, Srinagar, Jammu and Kashmir, India(**Corresponding author**)
[2]PG Scholar, Department of Conservative Dentistry, GDC & H, Srinagar, Jammu and Kashmir, India
[3]Professor & Head, Department of Conservative Dentistry, GDC & H, Srinagar, Jammu and Kashmir, India
[4]Associate Professor, Department of Conservative Dentistry, GDC & H, Srinagar, Jammu and Kashmir, India
[5]Principal and Dean, GDC & H, Srinagar, Jammu and Kashmir, India

**Abstract:**

**Background:** To assess the efficacy of aerosol suction device when used along with a noval directional airflow. **Materials & methods:** There was an experiment conducted in a standard indoor dental procedural room in dental college(10”*6”) with a single-chair clinical space separated by a barrier wall on a dental manikin. The air-handling system functioned as per usual practice.No other clinical activities occurred concurrently with the experiments.Simulated dental procedure, Droplet spatter detection, Esu operating conditions was considered.At the conclusion of each simulation, the paste coated and methylene blue contaminated strips were photographed against a white background under ambient lighting conditions using a Nikon 850 digital camera and 50-millimeter lens from a distance of 37.5 inches (F-stop 5.6, 1/60 second, & ISO 400.Hence, it was a methodology for evaluating the efficacy of aerosol suction device when used along with a noval directional airflow. **Results:** A comparative study was conducted among 3 groups. Group A showed the average rate of 2.176%, group B had an average percentage of 31.966 percent and the group C had 2.513 percent in evaluating the efficacy of aerosol suction device when used along with a noval directional airflow. **Conclusion:** During the SARS-Cov-2 pandemic, which places increased focus on procedural risk reduction and infection control for dentistry, practical additional means of protection become more critical. The adoption of the use of ESUs for clinical procedures can help reduce procedural spatter, surface contamination, and potential transmission of the SARS-CoV-2 virus in the dental setting.ESUs, however, do represent a feasible and practical means of augmenting infection control procedures during clinical oral health care that are particularly important during the COVID-19 pandemic.

**Keywords:** Aerosol, PPE, SARS-Cov-2.

## Introduction:

In the midst of the SARS-CoV-2 pandemic, increasing emphasis has been placed on limiting the spread of the virus and protecting healthcare workers and the public. Owing to the close proximity of oral health care providers (that is, dentists, dental hygienists, and dental assistants) to a patient’s face during aerosols and mist generating procedures, Clinical dentistry poses an exposure risk to dental professionals and patients. These aerosols are contaminated with bacteria, blood, viruses and fungi, facilitating the spread of infectious diseases, including tuberculosis, pneumonia, influenza, and others.[1]

The emergence of SARS-CoV-2 has generated renewed interest in the potential transmission of viral contaminants via dental procedures as the frequent use of high-speed handpieces and ultrasonic scalers capable of aerosolizing bodily fluids like saliva and blood, there is heightened potential for SARS-CoV-2 transmission in these professionals. [2]

Fear and anxiety among dentists prevailed during the COVID-19 pandemic. q Were reluctant to perform routine dental procedures. In a report about physician death from COVID-19, 6% (16/254) of physicians who died from COVID-19 were dentists in addition to general practitioners and emergency room doctor, 43% (108/254).[3]

Extraoral and oral suctions are indicated as excellent machinery and tools to protect against viral and bacterial infections in droplets and aerosols during clinical treatment highly recommended in clinical set-ups. It offers flexibility in terms of positioning the collector relative to the patient's face. But guidance on appropriate distance from the patients mouth is limited. 10 t0 15 cm is considered effective distance beyond which the efficacy drastically decreases.[4]

## Aim of the study:

It becomes cumbersome to work very effectively with hood of the ESD at such a short distance. Therefore the purpose of this study is to measure the efficacy of ESD at an increased and workable distance from mouth of the patient in presence of an additional directional airflow by using a simple portable fan.[5]

## Materials and methodology:

There was an experiment conducted in a standard indoor dental procedural room in dental college(10"*6") with a single-chair clinical space separated by a barrier wall on a dental manikin.

The air-handling system functioned as per usual practice.

No other clinical activities occurred concurrently with the experiments.

The dentist wore PPE with leg covers, shoe covers, general medical masks, and gloves. In addition, the outer layer of the face shield was covered with white paper, leaving a rectangular opening on the eye to avoid interference to the line of sight.

The manikin was set to a reclined position to simulate the clinical operatory position of the patient for dental procedure.

The manikin head was also covered with a white paper.

## Simulated dental procedure:

A dental manikin with thermoplastic teeth was set up on a dental chair to simulate the patient to avoid unnecessary risk to the patients. Air turbine (NSK DynaLED High-Speed) procedures were carried out with standard diamond burs and operated at full speed (450,000 rpm) with irrigation from the water line The handpiece water feed rate was at maximum flow rate. All simulations were conducted by the same right-handed dentist. Tooth preparation of the tooth no. #11 and #12 was done for 5 minutes in each experiment. With a distance between the operator's face shield and the patient's mouth of 30 cm.

## Droplet spatter detection:

Adhesive surgical tape and white paper strips with dimensions 1*4 inches were pasted in four different directions from the mouth of the manikin and on face shield at 3, 6, 9, and 12 o'clock positions to detect the aerosol contamination. These strips were pasted on already pasted whitepaper which will act as a neutral background during photography of these strips.

In order to visualize aerosolized particles and/or splatter, methylene blue dye was mixed with water at a concentration of 0.5g dye to 500cc of water. This was added to the water reservoir of air-rotor. This contamination will be visualized on white strips pasted strategically on manikin head and face shield.

Immediately before each simulated dental procedure, the non adhesive side of the adhesive strips were painted with a thin layer of AQUADIS Water Finding Paste, which instantaneously changes from green to pink when it comes into contact with liquid water.

## Esu operating conditions:

An ADS EOS Extraoral Suction System (ADS Dental System) was used for the experiment.

The floor-standing ESU was positioned at the foot of each patient at 7 o'clock position, six feet from the operator with the evacuation hood directly facing the oral cavity at two different distances ,15 and 30 cm.

Distances were confirmed before and after each simulation. During procedures not involving the EOS, the unit was removed from the surgery.

The door of the closed surgery was kept shut during and after all procedures. After completion of each procedure, clinicians left the room for 20 minutes, allowing particles to settle.

At the conclusion of each simulation, the paste coated and methylene blue contaminated strips were photographed against a white background under ambient lighting conditions using a Nikon 850 digital camera and 50-millimeter lens from a distance of 37.5 inches (F-stop 5.6, 1/60 second, & ISO 400.

**Figure 1: Manikin Head covered with white paper**

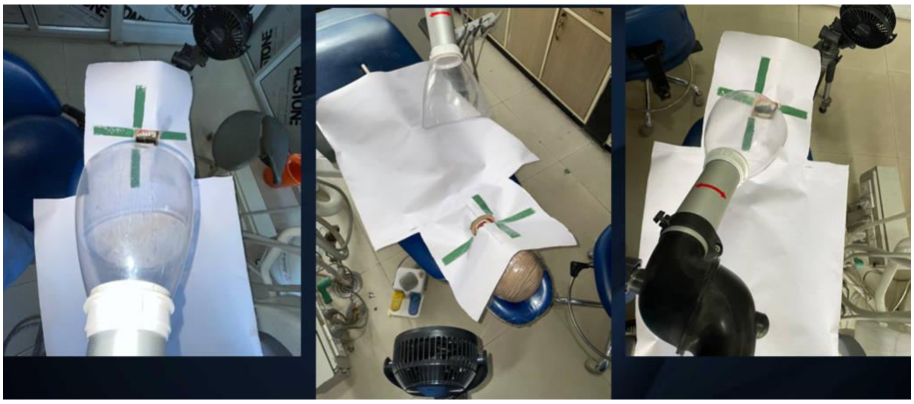

**Figure 2**

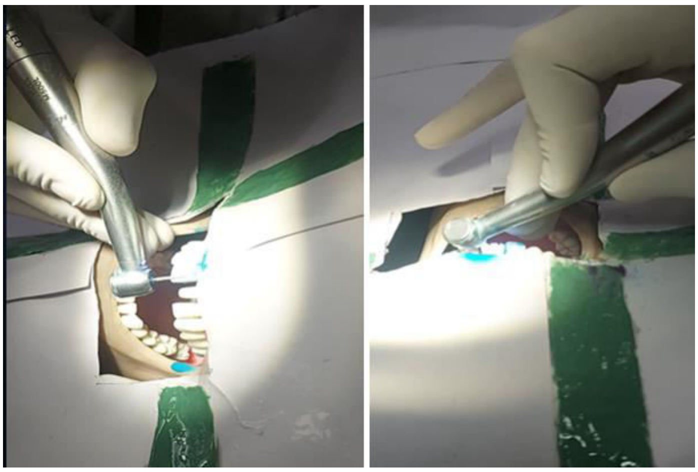

**Figure 3**


**Figure 4**


**Figure 5**

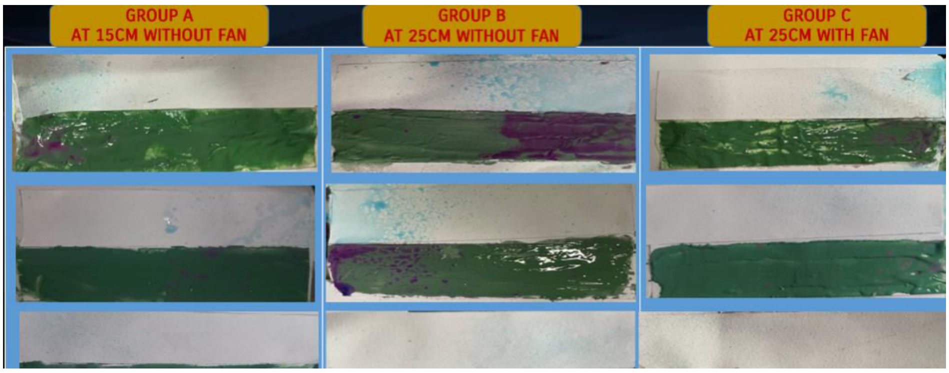


**Figure 6**

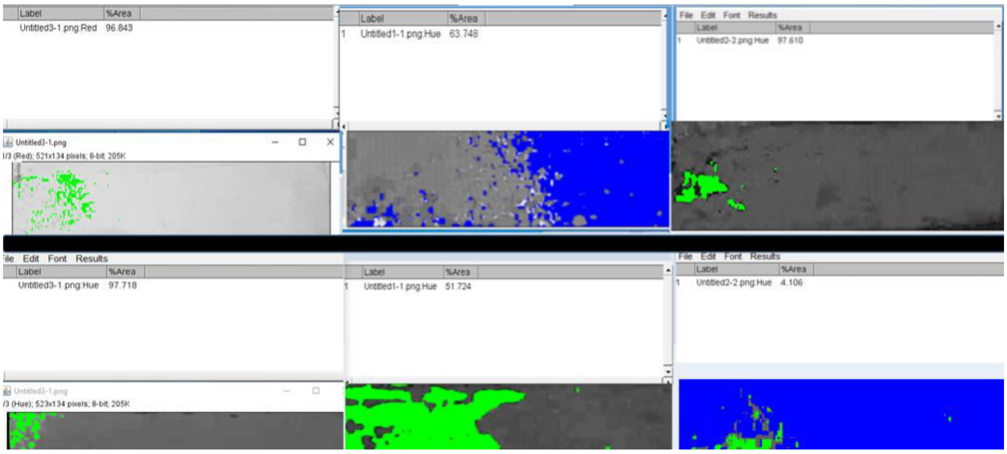


**Figure 7**

## Results:

### Groups:

A. ESU AT THE DISTANCE OF 15CM FROM THE CENTRAL INCISOR OF MANIKIN HEAD WITHOUT ANY PORTABLE FAN ON OPPOSITE SIDE
B. ESU AT THE DISTANCE OF 25 CM FROM THE CENTRAL INCISOR OF MANIKIN HEAD WITHOUT THE PORTABLE FAN ON OPPOSITE SIDE
C. ESU AT THE DISTANCE OF 25 CM FROM THE CENTRAL INCISOR OF MANIKIN HEAD WITHOUT THE PORTABLE FAN ON OPPOSITE SIDE

## Aerosol spatter image analysis:

Photographs of the paste-coated and methylene stained strips were imported into Photoshop, Version 21.2.0 (Adobe).Photoshop's (Adobe) spot healing brush tool was used. Then threshold setting was chosen to allow visualization of dark pink and blue droplet spatterin green and white background respectively. Photoshop's histogram tool was then used to determine the percentage of colored pixels by selecting histogram levels 0 through 50, which correspond with the area of droplet spatter (percentage spatter) within the image. The same procedure was applied to each experimental simulation. Validation tests associated with the use of paste to detect water droplets were described in detail by Kundoor and Dalby.

### Group A: At 15 cm without FAN:

| STRIP NO. | %age area |
|---|---|
| 1 | 3.17 |
| 02 | 2.82 |
| 03 | 1.51 |
| 04 | 3.56 |
| 05 | 3.92 |
| 06 | 2.98 |
| 07 | 1.06 |
| 08 | 1.56 |

**AVERAGE: 2.176 %**

### Group B: At 25 cm without FAN:

| STRIP NO. | %age area |
|---|---|
| 01 | 63.74 |
| 02 | 51.72 |
| 03 | 57.29 |
| 04 | 44.26 |
| 05 | 27.96 |
| 06 | 19.51 |
| 07 | 23.78 |
| 08 | 18.76 |

**AVERAGE: 31.966%**

### Group C: At 25 cm with FAN:

| STRIP NO. | %age area |
|---|---|
| 01 | 2.39 |
| 02 | 4.10 |
| 03 | 1.06 |
| 04 | 2.88 |
| 05 | 1.79 |
| 06 | 3.43 |
| 07 | 1.79 |
| 08 | 2.67 |

**AVERAGE: 2.513 %**

So, it was concluded that group A showed the average rate of 2.176%, group B had an average percentage of 31.966 percent and the group C had 2.513 percent.

## Discussion:

This study was conducted to evaluate the amount of aerosol and splatter produced during tooth preparation using a high-speed handpiece, at two different distances in presence of a simple and portable fan. This simple and easy available device gives the directional flow to the generated aerosols and greatly increases the efficacy of ESUs. There was statistically significant increase in the efficacy of ESU in presence of an additional directional airflow device.

Ahmed et al. reported that fear and anxiety among dentists of acquiring COVID-19 infection unintentionally causing harm to their families. So this study was designed to follow the recommendations from the ADA (American Dental Association) interim guidance to curb the transmission of COVID-19.[6]

Clinical ventilation plays a major role in mitigating the spread of airborne infections. Sarapultseva et al. reported that the use of aspirating systems installed with HEPA (high-efficiency particulate air) filters can help to evacuate and dissipate aerosols into a specialized area away from the dental practice, thus providing a safe ambiance to the dental staff, especially in the era of the COVID-19 pandemic. However, these are expensive equipment and are not cost-effective.[7]

In two recent reports, Zemouri et alhave reported that the highest transmission possibilities estimated in a dental clinic were for measles virus (100%), followed by coronaviruses (99.4%), influenza virus (89.4%), and M. tuberculosis (84%).[8]

Since the beginning of the pandemic, there has been an increase in use of extraoral suction devices. Despite reports of measurable droplet and splatter reduction have encouraged the ESU use in routine dental practice,other authors did not find neither significant droplet and splatter counts decrease nor environmental contamination reductions unless the HVE aspirator was subject to modifications.[9]

The reason being need to place the suction hood very close to the mouth of patient that interferes with four-handed dentistry and makes the use of other sophisticated equipments cumbersome like loupes, dental operating microscope.

Particle counts show that ESU use is associated with a reduction in total particle count for each zone evaluated, with the largest reduction seen in regions closest to the origin.[10]

In our study we wanted a cheap and easily available alternative that would be possible for every clinician specially those working in small towns, unable to spend much, as self-protection was more important for clinicians that were exposed to (direct or indirect) airborne diseases, such as influenza or COVID-19 due to aerosol production.[11]

## Conclusion:

During the SARS-Cov-2 pandemic, which places increased focus on procedural risk reduction and infection control for dentistry, practical additional means of protection become more critical. The adoption of the use of ESUs for clinical procedures can help reduce procedural spatter, surface contamination, and potential transmission of the SARS-CoV-2 virus in the dental setting.[12]

ESUs provide an affordable, practical method of reducing aerosols and droplet spatter during clinical procedures. The ESUs are maneuverable, did not impede workflow, and provided an additional level of protection for clinical providers. We tried to overcome only drawback of the Eus with a simple portable fan which is cost effective and easily available.[13]

Patient screening, PPE, 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. ESUs, however, do represent a feasible and practical means of augmenting infection control procedures during clinical oral health care that are particularly important during the COVID-19 pandemic.

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