Original Research Article

Aerosol Contamination in The Dental Operatory During Oral Prophylaxis: An Occupational Hazard.

ABSTRACT

Aim:To investigate the level of aerosol contamination following oral prophylaxis using ultrasonic scalers at different positions in the dental operatory at different time.

Study design:observational study.

Place and Duration of Study: Department of Periodontics, Saveetha Dental College and Hospitals, Chennai, between December 2020 and February 2021.

Methodology: In a pre-fumigatedroom of 10m*15m scaling was performed using ultrasonic scalers along with high volume suction while maintaining all aseptic precautions. Blood agar plates were positioned at the level of patient's chest (P1), doctor'schest (P2), assistant's chest (P3), on the floor directly below the patients headrest (P4) and 4 feet away from the dental chair at a height 3 feet above the ground (P5) to assess aerosol contamination occurring during scaling procedure. Similarly, blood agar plates were position at P3,P4,P5 for a time interval of 15 minutes after 1 and 3 hours of the procedure respectively to assess the levels of aerosol post procedure.

All the blood agar plates were incubated at 37°C for 24 hours, following which bacterial colony forming unit (CFU) was calculatedfor each plate and gram staining was performed to identify the organism present.

Results: At the time of procedure the patient was most exposed to the aerosol. At the end of 3 hours the percentage of aerosol reduction was 81 %. Gram staining showed that the streptococci were predominant

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organisms with a few short rods as observed on the plates obtained during the procedure, while gram positive bacilli were seen abundantly in samples obtained at the end of 3 hours.

Conclusion: The study examined the spreading characteristics of aerosol during and after scaling procedure. Even after 3 hours of completion of the procedure some amount of aerosol present in the room. Hence, the dentist must ensure proper precautionary measures to prevent air-borne nosocomial infections.

Keywords: aerosol, contamination, oral prophylaxis.

1. INTRODUCTION

The human mouth is a highly contaminated environment, the dentist and dental hygienist are exposed to a variety of bacteria, viruses, fungi and protozoan. The dental biofilm contains 2x 10^8 microorganisms and over 500 different species [1]. High-powered devices such as airotors and ultrasonic scalers need compressed air and water to work effectively. Procedures performed by the dental team using these devices have the potential for creating contaminated aerosols and splatter.

1. Aerosols are droplets and or tiny particles which remain suspended in air. The size of the particle varies from 0.001 mm to100 µm or more. The small particle of size ranging from 0.5 µm to 10 µm have the greatest potential to penetrate the respiratory passages and the lungs, hence, they possessing the ability to transmit diseases [2]. These aerosols are a potential source of infection as they are grossly contaminated with microorganisms and blood. Microorganism present in the mouth and upper respiratory tract can be transported in the aerosol produced during dental procedures such as restorations or scaling, leading to infection of the respiratory system, skin infections and other systemic diseases in immuno-compromised patient [3]. There is some evidence for greater prevalence of respiratory diseases and elevated antibody levels to *Legionella pneumophila* in dental workers [4]. The detection of oral bacteria as far as two meters away from the operatory site is indicative of the existence of aerosolized oral bacteria in

dental practice [5]. The use of ultrasonic scalers and highspeed hand pieces are responsible for increased aerosol contamination and decreased air quality in the dental office [6]. Scaling with ultrasonic scalers generate aerosols contain millions of bacteria per cubic foot of air, bacteria could be recovered 6 inches from the mouth of patient and the CFUs formed were significantly reduced when aerosol reduction device are used [7].

Past evidence is available for aerosol contamination due to dental procedures. However, this study is novel because it aims to investigate the level of bacterial contamination by aerosol following oral prophylaxis using ultrasonic scalers in three dimensions: namely at different positions in the dental operatory and at different time levels.

MATERIAL AND METHODS

A single chaired, well ventilated, closed-operatory measuring 10 feet x 15 feet, with the facility to fumigate the room was chosen for all treatment procedures. A single patient was treated in the room on each of the study day. A total of 5 patients requiring oral prophylaxis and consenting to be a part of the study were included.

The room was fumigated on the day prior to the day the test patients were treated and all surfaces were cleaned with 2% glutaraldehyde solution. Sodium Hypochlorite (0.5%) was flushed through the tubing of dental chair waterline followed by water flushing to remove the unwanted biofilm from the tubing surfaces. The following morning, on the day of the procedure, a sterile Petri dish containing blood agar is left on the dental chair for 15 minutes and then incubated for 24 hours at 37°C to assess the sterility of the dental operatory prior to the start of any dental procedure.

The operator as well as the assistant wore sterile surgical gloves, face masks, head caps and used protective eye-glasses throughout the procedure, while the patient wore a sterile surgical drape (figure 1).

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In this cross-sectional study as mentioned earlier how the sample size had been chosen and according to what?

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If at the same day , its incubated 24 hrs so how the author assess the sterility of the operatory room

Figure 1: Positioning of agar plates.

Using a double-sided tape, sterile blood agar petri dishes were taped onto the chest of the dentist (position P1), assistant (position P2) and patient (position P3). Agar Petri dishes were placed at ground level just below the patient's head (position P4) and at a distance of 4 feet from the dental chair at a height 3 feet above the ground (position P5). A through sub gingival scaling was performed with the speed water settings set at moderate levels. A high vacuum suction was used at all times. After completion of the procedure the agar plates were labelled and incubated for 24 hours at 37°C to assess the level of contamination at the baseline or time T0.

After 1 hour, agar plates were placed on the head rest of the dental chair, on the floor directly below the head rest (corresponding to position P4) and at a distance of 4 feet away from the dental chair at a height 3 feet above the ground (corresponding to position P5). The plates were left open for 15 minutes after which the petri dishes were labelled and incubated for 24 hours at 37°C to assess the spread of aerosol after 1 hour of procedure of time T1. The same was repeated after 3 hours of the procedure the and time period was called as T2.

All agar plates were incubated for 24 hours at 37°C after which each of the agar plate was examined for colony count, colony morphology and Gram staining was performed to identify the bacteria present (Figure 2).

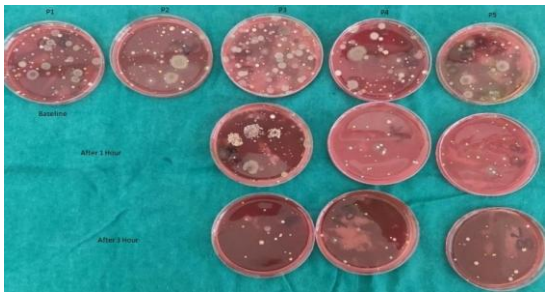

Figure 2: Agar plates after 24 hours of incubation at 37^0C according to position and type.

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RESULTS AND DISCUSSION

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The data was collected, tabulated and analyzed. Table 1 depicts mean CFU at different positions at different time intervals. At the time of scaling patient (position P3) was most exposed to aerosol, followed by dentist (position P1) and dental assistant (position P2), least amount of aerosol was detected 4 feet away from the dental chair (position P5) (Figure 3).

Table 1: Distribution of aerosol in different positions at various time intervals.

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Time	Positions				
	P1	P2	P3	P4	P5
T0 – Baseline	203 ± 5.71	181 ± 13.47	469 ± 17.45	141.66 ± 7.03	147 ± 6.16
T1 – After 1 hr	-	-	145.33 ± 7.94	57.33 ±13.57	60 ±4.63
T2 – After 3 hr	-	-	53.33 ± 9.84	32.66 ± 8.73	28.33 ± 7.94

P1 – Dentist, P2 – Assistant, P3 - Patient/ head rest at reclined position, P4 - Floor level below chair head rest at reclined position, P5 - 4 feet away, 3 feet above the ground

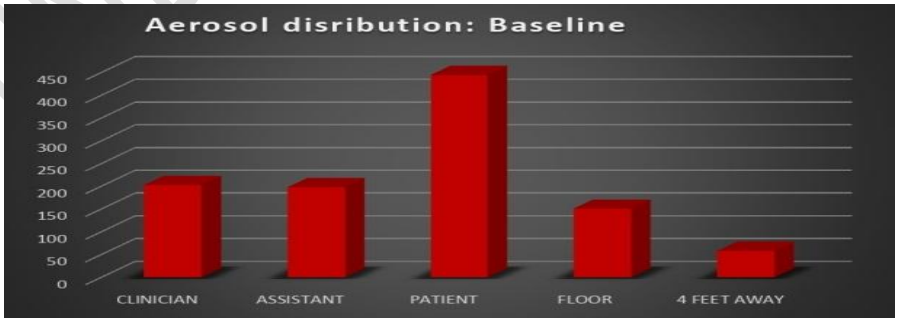

Figure 3: Baseline distribution of aerosol.

Percentage reduction in CFU was calculated at different positions at 1 and 3 hours post scaling. At 1- hour, maximum reduction (67.78%) was seen at the headrest position (position P3) and the percentage reduction from baseline of CFU was 89.07% at position P3 at 3 hours after scaling. Even after 3 hours some amount of aerosol remained suspended in the air (Fig 4). Gram staining revealed the presence of abundant *streptococci*, *staphylococci, and few bacilli* (Fig.5).

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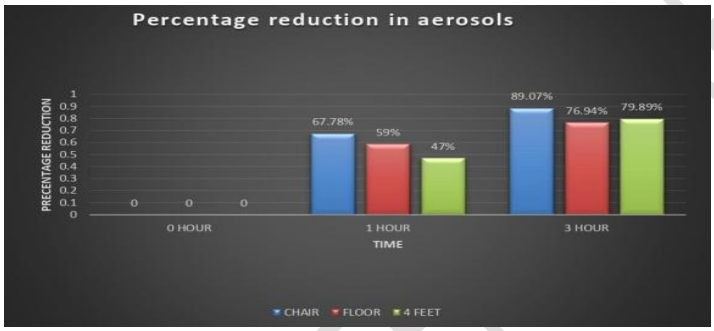

Figure 4: Percentage reduction from baseline at 1 and 3 hours at different positions.

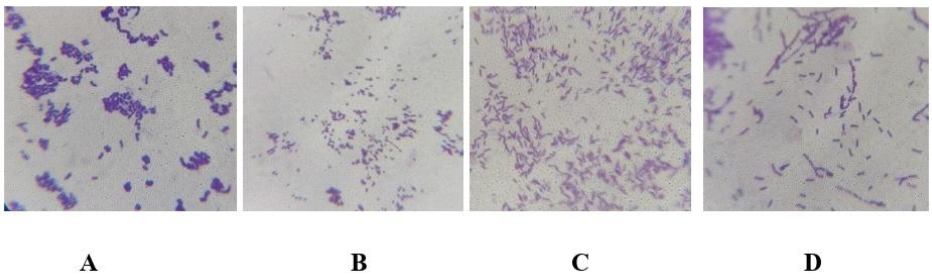

Figure 5: Gram staining of the organisms cultured. Gram positive cocci in clusters (A), Gram positive cocci in pairs (B), Gram positive bacilli (C) and Gram positive bacilli in chains (D).

This study was conducted with the aim to investigate the level of aerosol contamination occurring during scaling procedure in terms of time and distance from the dental chair. Modern dental procedures are

associated with aerosol production; in particular, ultrasonic scalers have been reported to generate more aerosols than hand pieces and air-water syringes [8]. Ultrasonic scaling produces a huge volume of aerosol; which apart from air and water, the aerosol contains blood, saliva and microbes contained in them. These organisms could lead to the occurrence of nosocomial infection in susceptible individuals. With the emergence of newer perio-pathogens, it is very important to treat every patient as a potentially infective patient in our everyday practice.

Patients periodontal status, type of evacuator used and use of preprocedural rinse are some factors which influence aerosol distribution [9]. The use of an ultrasonic scaler is associated with an increase in the prevalence of respiratory disease in dental medical staff [10]. Dentists and dental hygienists who used an ultrasonic scaler for more than 60 min a day showed a higher rate of eye and skin infections [11].

Our study found that the patient followed by the clinician and assistant were in the most contaminated zone, these results were similar too these seen by Veena H R et al who studied aerosol distribution during scaling on a mannequin fitted with phantom jaws on a dental chair [12]. According to Bennet et al the aerosol remained suspended in the air even after 30 mins, in our study we found that approximately 20% of aerosol still remainedsuspended in the dental operatory even after 3 hours [13]. Use of pre-procedural rinses reduced the aerosol contamination [14].

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The COVID-19 pandemic, where the virus is transmitted through aerosols has shifted the focus on how the dental operatory is a highly infectious zone and that measures to prevent infection transmission by aerosols must be implemented as a part of dental practice [15]. In order to protect the dental personnel's face mask, protective eye wear or face shield need to be used. The use of a high-volume evacuator with a wide bore suction tip should be employed during ultrasonic scaling. The large bore suction tip with a diameter of 8 mm or more can remove air at the rate of 100 cubic feet per minute, this reduces aerosol and splatter by 93–96% [16]. There is also a potential risk for airborne contaminants to enter the ventilation system and spread infection. High efficiency particulate air (HEPA) filters and UV chambers in the ventilation system can minimize the risk of air contamination [17]. Air disinfection with UV

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lamp emitting ultra-violet light at 250–265 nm shows bactericidal, fungicidal and viricidal action, the mechanism of action is by the destruction of DNA chains and protein denaturation in the organisms [18].

Limitation of this study was its cross-sectional nature and that quantification of individual pathogens was not done. Also, most periodontal pathogens are facultative or obligate anaerobes, hence we cannot directly implicate the periodontal pathogens to cause aerosol-based infections.

CONCLUSION

Comment [nm12]: Need to be extended and express the findings from the results

Within the limits of this study, we saw the spreading characteristics of aerosol at different positions in the dental operatory at various time intervals. Even after 3 hours after scaling some amount of aerosol remained suspended in the air.The dentist must ensure proper precautionary measures to prevent air-borne nosocomial infections.

Comment [nm13]: No conflict of interest declaration

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