Aerosol, a health hazard during ultrasonic scaling: A clinico-microbiological study

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ABSTRACT

Context: Ultrasonic scaling is a routinely used treatment to remove plaque and calculus from tooth surfaces. These scalers use water as a coolant which is splattered during the vibration of the tip. The splatter when mixed with saliva and plaque of the patients causes the aerosol highly infectious and acts as a major risk factor for transmission of the disease. In spite of necessary protection, sometimes, the operator might get infected because of the infectious nature of the splatter.

Aim: To evaluate the aerosol contamination produced during ultrasonic scaling by the help of microbiological analysis.

Materials and Methods: This clinico-microbiological study consisted of twenty patients. Two agar plates were used for each patient; the first was kept at the center of the operatory room 20 min before the treatment while the second agar plate was kept 40 cm away from the patient’s chest during the treatment. Both the agar plates were sent for microbiological analysis.

Statistical Analysis: The statistical analysis was done with the help of STATA 11.0 (StataCorp. 2013. Stata Statistical Software, Release 13. College Station, TX: StataCorp LP, 4905 Lakeway Drive College Station, Texas, USA). Statistical software was used for data analysis and the $P < 0.001$ was considered to be statistically significant.

Results: The results for bacterial count were highly significant when compared before and during the treatment. The Gram staining showed the presence of Staphylococcus and Streptococcus species in high numbers.

Conclusions: The aerosols and splatters produced during dental procedures have the potential to spread infection to dental personnel. Therefore, proper precautions should be taken to minimize the risk of infection to the operator.

Key words: Aerosol, scaler, splatter
Aerosol contamination during ultrasonic scaling

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concluded that aerosols generated from the patients’ mouth contain millions of bacteria per cubic foot of air. King et al.\[6\] reported that bacteria could be recovered 6 inches from the mouth of patient and the CFUs formed were significantly reduced when aerosol reduction device was used. Aerosol may contain Mycobacterium tuberculosis,\[7\] human immunodeficiency virus, and hepatitis virus.\[8\] Therefore, the aim of the study is to evaluate the contamination produced during ultrasonic scaling with the help of microbiological analysis.

**MATERIALS AND METHODS**

A single center, double-masked, randomized study was carried out after the approval from the Ethical Committee of the Institution. A total number of 20 patients were randomly selected from the outpatient department of periodontics. Inclusion criteria were (1) a minimum number of 20 teeth present, (2) age ranging between 18 and 60 years, (3) systemically healthy patients, (4) a minimum oral hygiene score of 3–4 (Oral Hygiene Index Simplified), (5) pocket probing depth of ≥5 mm, and (6) nonsmokers and nonalcoholic patients. Exclusion criteria were (1) patient on systemic antibiotics in the past 6 months, (2) undergone oral prophylaxis within the last 3 months, and (3) pregnant or lactating women. The patients were informed of the protocol and the written consent was obtained from the patients. Before starting the treatment, care was taken to maintain a clean sterilized environment with fumigation in the working cubicle. A standardized location was used to place the nutrient agar (enriched with 5% sheep blood) plates to collect the airborne particles before and during the treatment. Two agar plates were used for each patient (one plate was kept at the center of the operatory room [cubicle] 20 min before the scaling procedure, and the other plate was kept 40 cm away from the working area near the patient’s chest for 20 min during the scaling). The same closed operatory room was used for all the treatment procedures. The scaling or oral prophylaxis was carried out at a standardized dental chair and the same patient positioning. The same dentist performed all the treatment procedures on all days and only one patient was carried out in 1 day to allow the operator room to be free of aerosols. The oral prophylaxis was carried out with the help of piezoelectric ultrasonic scaler at a constant frequency, and the pressure of the coolant was maintained at constant level. A motorized suction was used during the treatment procedure. After the treatment procedure, the agar plates were sent for the microbiological analysis carefully.

**Microbiological analysis**

Both the agar plates were incubated at 37.4°C for 3 days and were cultured aerobically. The various tests such as Gram staining, catalase, coagulase tests, and the CFU were counted microbiologically by the same microbiologist. The Gram staining was done as per standard method.\[9\] The catalase test was done by placing a drop of 3% hydrogen peroxide on a microscope slide; then, with the help of an applicator stick, the microbiologist touched the colony and then smeared a sample into the hydrogen peroxide drop. If the mixture produces bubbles or froth, the organism is said to be “catalase-positive” and if the bubbles are not produced, then the organism are considered “catalase-negative.” Coagulase test was done by the slide and tube methods.

**RESULTS**

The results were statistically analyzed using Wilcoxon-signed ranked test. Table 1 illustrates the air contaminants and the mean CFUs preoperatively and during the treatment procedure found from the samples obtained from agar plates. The results for bacterial count were highly significant when compared before and during the treatment. Table 2 shows the increase in the CFUs during the treatment procedure. The various tests such as Gram staining, catalase, and coagulase were also performed to identify the type of the bacteria involved which showed the presence of Staphylococcus aureus, Staphylococcus epidermidis, and streptococci in high numbers. The Gram staining revealed the type of bacteria (Gram-positive or Gram-negative); however, to differentiate between the Staphylococcus and Streptococcus, the catalase test was done by the slide and tube methods.

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### Table 1: Colony forming units on agar plates preoperatively and during the procedure

| Patient | CFU preoperative | CFU during treatment |
|---------|------------------|----------------------|
| 1       | 2.3x10^4         | 1.9x10^5             |
| 2       | 2.6x10^5         | 2.6x10^6             |
| 3       | 1.9x10^5         | 1.9x10^6             |
| 4       | 2.8x10^4         | 2.4x10^5             |
| 5       | 2.6x10^6         | 1.7x10^6             |
| 6       | 3.7x10^5         | 2.3x10^6             |
| 7       | 1.7x10^5         | 1.4x10^6             |
| 8       | 2.5x10^5         | 2.7x10^5             |
| 9       | 2.4x10^5         | 2.9x10^5             |
| 10      | 1.8x10^5         | 1.6x10^5             |
| 11      | 2.3x10^5         | 1.8x10^5             |
| 12      | 3.4x10^5         | 2.1x10^5             |
| 13      | 3.2x10^5         | 1.7x10^5             |
| 14      | 1.6x10^5         | 2.3x10^5             |
| 15      | 1.5x10^5         | 2.1x10^5             |
| 16      | 1.6x10^5         | 2.6x10^5             |
| 17      | 2.4x10^5         | 2.8x10^5             |
| 18      | 2.2x10^5         | 1.7x10^5             |
| 19      | 2.1x10^5         | 2.5x10^5             |
| 20      | 2x10^3           | 1.6x10^5             |

**CFU**=Colony forming unit

### Table 2: The Wilcoxon-signed rank test showed highly significant results

|                  | CFU (log value) Mean±SD | Median | \(P\)   |
|------------------|-------------------------|--------|---------|
| **Preoperative** | 4.206±0.932             | 4.229  | <0.001**|
| **Postoperative**| 7.869±0.862             | 8.267  |         |

\(P>0.05; \text{NS}, \text{**}P<0.001; \text{highly significant} \); CFU=Colony forming unit, NS=Not significant, SD=Standard deviation
test was performed and to differentiate between species of *Staphylococcus*, the coagulase test was performed. If the catalase test comes positive (by production of bubbles or froth), it confirmed the presence of *Staphylococcus* species. If coagulase test comes positive (when clumping is seen), it confirmed the presence of *S. aureus*.

**DISCUSSION**

The results of this study confirm the findings by others of unusually high levels of microorganisms in aerosols after using the ultrasonic handpieces. These aerosols may be contaminated with microorganisms and found in greatest concentration within 2 feet of the patient, where the dental health professional is usually positioned.[10] The ultrasonic scaling is associated with increased air contamination levels confirming the results reported by several other studies showing that this procedure is one of the greatest producers of airborne contaminants in dentistry.[11,12] Recent studies have highlighted the spread of infection through the air resulting from the most intensive aerosol and splatter emission that occur from an ultrasonic scaler tip and bur on a high-speed handpiece.[13,14] Basu et al.[15] did a survey of aerosol-related symptoms in dental hygienists using ultrasonic scalers. They found that symptoms such as nasal irritation, persistent cough, runny eyes, and itchy and dry skin were more common in dental hygienists than in nurses and hospital staff. The coagulase-positive *Staphylococcus*, which was present in 6.6% of the samples, can cause a wide variety of diseases in humans through either toxin production or invasion. Of great significance, the species *S. aureus* is an important pathogen agent that causes wound and human skin infections and nosocomial infections. Similar results were obtained in this study confirming that the infectious airborne particles are the major risk factors for the transmission of various diseases. The control and minimization of microorganisms contained in aerosol are of great importance to the health of dental personnel. Reports have associated these aerosols with respiratory infections, ophthalmic and skin infections, tuberculosis, and hepatitis B. That research shows that both the operator and the patient are exposed to high amounts of bacteria. Hence, the possibility of transmission of infections by aerosols to dental personnel through the respiratory route has been repeatedly pointed out. Less attention has been focused on another potential hazard, namely, bacteremia that may be caused by forcing microbial water contaminants through gingival crevices or periodontal pockets during scaling with ultrasonic devices or during surgical procedures requiring water irrigation and use of water-cooled high-speed handpieces. Caution is especially advised when treating patients undergoing immunosuppressive or prolonged antibiotic and/or corticosteroid therapy since it has been shown that these patients are susceptible to infections caused by microorganisms that are considered to be nonpathogenic to healthy individuals.

**CONCLUSION**

The aerosols and splatters produced during dental procedures have the potential to spread infection to dental personnel and other people in dental clinic. It is difficult to completely eliminate the risk posed by dental aerosols; it is possible to minimize the risk with relatively simple and inexpensive precautions such as personal barrier protection, preprocedural mouth rinse with an antimicrobial mouth rinse before treatment, use of high volume suction apparatus, and use of rubber dam where applicable. The use of these precautions will reduce the risk of an aerosolized spreading of infection to a minimum level. Further studies are needed to evaluate the antibiotic sensitivity for these bacteria to eliminate the various symptoms and the disease processes.

**REFERENCES**

1. Acharya S, Priya H, Purohit B, Bhatt M. Aerosol contamination in a rural university dental clinic in South India. Int J Infect Control 2010;6:1-7.
2. Bentley CD, Burkhart NW, Crawford JJ. Evaluating splatter and aerosol contamination during dental procedures. J Am Dent Assoc 1994;125:579-84.
3. Williams GH 3rd, Pollok NL 3rd, Shay DE, Barr CE. Laminar air purge of microorganisms in dental aerosols: Prophylactic procedures with the ultrasonic scaler. J Dent Res 1970;49:1498.
4. Miller RL, Mickel RE, Abel C, Ryge G. Studies on dental aerobiology: II. Microbial splatter discharged from the oral cavity of dental patients. J Dent Res 1971;50:621-5.
5. Miller RL. Generation of airborne infection by high speed dental equipment. J Am Soc Prev Dent 1976;4:14-7.
6. King TB, Muzzin KB, Berry CW, Anders LM. The effectiveness of an aerosol reduction device for ultrasonic scalers. J Periodontol 1979;68:45-9.
7. Cottone JA, Terezhalmy GT, Molinari JA. Practical Infection Control in Dentistry. Baltimore: Williams & Wilkins; 1996. p. 139-40.
8. Miller RL. Characteristics of blood-containing aerosols generated by common powered dental instruments. Am Ind Hyg Assoc J 1995;56:670-6.
9. Ryan KJ, Ray CG. Sherris Medical Microbiology. 4th ed. New York: McGraw-Hill; 2004. p. 232-3.
10. Holbrook WP, MuirKF, Macphee IT, Ross PW. Bacteriological investigation of the aerosol from ultrasonic scalers. Br Dent J 1978;144:245-7.
11. Harrel SK, Barnes JB, Rivera-Hidalgo F. Aerosol and splatter contamination from the operative site during ultrasonic scaling. J Am Dent Assoc 1998;129:1241-9.
12. Timmerman MF, Menso L, Steinfort J, van Winkelhoff AJ, van der Weijden GA. Atmospheric contamination during ultrasonic scaling. J Clin Periodontol 2004;31:458-62.
13. Leggat PA, Kedjarune U. Bacterial aerosols in the dental clinic: A review. Int Dent J 2001;51:39-44.
14. Szymanska J. Dental bioaerosol as an occupational hazard in a dentist’s workplace. Ann Agric Environ Med 2007;14:203-7.
15. Basu MK, Browne RM, Potts AJ, Harrington JM. A survey of aerosol-related symptoms in dental hygienists. J Soc Occup Med 1988;38:23-5.