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Atmospheric contamination during ultrasonic scaling

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Abstract

Objective: The aim of this study was to determine the microbial atmospheric contamination during initial periodontal treatment using a piezoelectric ultrasonic scaler in combination with either high-volume evacuation (HVE) or conventional dental suction (CDS).

Methods: The study included 17 treatment sessions, consisting of a 40-min episode of continuous plaque and calculus removal using an ultrasonic unit (EMS). The treatment sessions were carried out in six patients with generalized adult periodontitis and ranged from two to four sessions per patient according to their needs. The use of HVE and CDS was randomly assigned over the sessions within each patient. Before each treatment, the operating room was not used for 15 h. To measure baseline microbial air pollution two Petri dishes containing blood agar were exposed for 10 min to the air. At the start of each treatment session, two Petri dishes were exposed for 5 min at a distance of 40 cm from the mouth of the patients. After 20 min, this procedure was repeated. At a distance of 150 cm, two Petri dishes were exposed for 20 min followed by exposure of two new Petri dishes for the rest of the session. The plates were cultured aerobically and anaerobically for 3 and 7 days, respectively.

Results: The mean colony forming units (CFU) before treatment never exceeded 0.6 colonies per plate. At 40 cm, the mean CFU, when considering a period of 40 min, was 8.0 for HVE and 17.0 for CDS. The mean CFU at 150 cm during this period was 8.1 with HVE and 10.3 with the CDS. With reference to the Air Microbial Index the operatory atmosphere was considered to be in a good condition during 40 min of continuous use of the ultrasonic scaler in combination with both HVE and CDS.

Conclusion: Within the restrictions of this study, only limited atmospheric microbial contamination is produced when using a piezoelectric ultrasonic scaler.

Key words: aerosol; microorganisms; ultrasonic scaler

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Treatment of periodontitis primarily aims towards the reduction of pathogens embedded in the subgingival biofilm. Mechanical debridement of the periodontal pocket has been demonstrated to significantly improve gingival health (Van der Weijden & Timmerman 2003). Although there is limited evidence of clinical efficacy and safety, there is a strong trend among clinicians to give preference to ultrasonic instruments for subgingival debridement (Tunkel et al. 2003). However, the generation of pathogenic bacterial aerosols is a concern for patients, staff and practitioners. These scalers produce a fine spray, which may be heavily contaminated with oral organisms and present a considerable microbial challenge to patients, the dentist and the nursing staff. The interest in dental aerobiology has been stimulated by concern with the obvious splatter caused by the visible particles emanating from the patient's mouth during dental procedures.

Miller et al. (1971) demonstrated that dental operations involving air and water sprays in combination with rotating instruments may cause levels of contamination exceeding those produced by common oral activities. They showed that a sneeze and the use of the air turbine handpiece produce comparable aerosols and splatter. A fourfold increase of airborne bacteria has been observed in areas where aerosol producing equipment was used (Gehring 1976). A considerable bacterial challenge exists in the aerosol produced by ultrasonic scalers and it is probable that viruses and bacteria may be spread in this way (Holbrook et al. 1978).

The traditional view of this bacterial contamination in the dental office is that these are non-pathogenic bacteria (Miller et al. 1978). However, studies have linked an increase in respiratory illness to the use of ultrasonic scalers (Rosen et al. 1985, Allsopp et al. 1997). With the reported resurgence in bacterial diseases

and the presence of other pathologic organisms with the potential for airborne transmission, there is an increased concern about aerosol contamination and decreased air quality in the dental office. Although the reports of occupationally incurred respiratory infection of dentists are limited, the tenets of medical aerobiology provide strong arguments for investigation of this potential occupational hazard. Bacterial contamination from ultrasonic scaler aerosol has been noted in the past (Larato et al. 1967, Suppipat 1974) and the interest was stressed again in more recent studies (Harrel et al. 1996, 1998, Rivera Hidalgo 1999).

In absence of recent research of bacterial aerosols created by piezoelectric ultrasonic scalers, the interest of the present study was the aerosol production in a modern dental operatory. The purpose of the present study was to determine the microbial atmospheric contamination during initial periodontal treatment using a modern and at present widely used piezoelectric scaler in combination with either high-volume evacuation (HVE) or conventional dental suction (CDS).

Material and Methods

Patient selection

For this study, six patients (age range 43–69 years, three males and three females) who were referred to the Academic Centre for Dentistry in Amsterdam (ACTA) for diagnosis and treatment of periodontitis, were included. They had at least three teeth in each quadrant. They were diagnosed as having generalized chronic periodontitis. The use of antibiotics or topical antiseptics was not allowed during a period of 30 days prior to the study.

Treatment

Treatment consisted of two to four sessions for each patient. A total of 17 treatment sessions was performed. After local anaesthesia of the area to be treated, during two subsequent periods of 20 min, plaque and calculus were removed by continuous use of an ultrasonic scaler (Piezo Master 400, EMS®, Nyon, Switzerland). This is a stand-alone, piezoelectric-driven ultrasonic device with an exchangeable 250 ml coolant reservoir. The tip of the instrument was kept as much as possible in contact with the teeth during the entire scaling episode in order to minimize the aerosol production not associated with the actual scaling procedures. Power and supply of coolant were turned to moderate setting, approximately to a 2 o'clock position. A perio-slim tip (PS-tip, Fig. 1) was used. In this combination, a fine water spray was generated at the tip of the device.

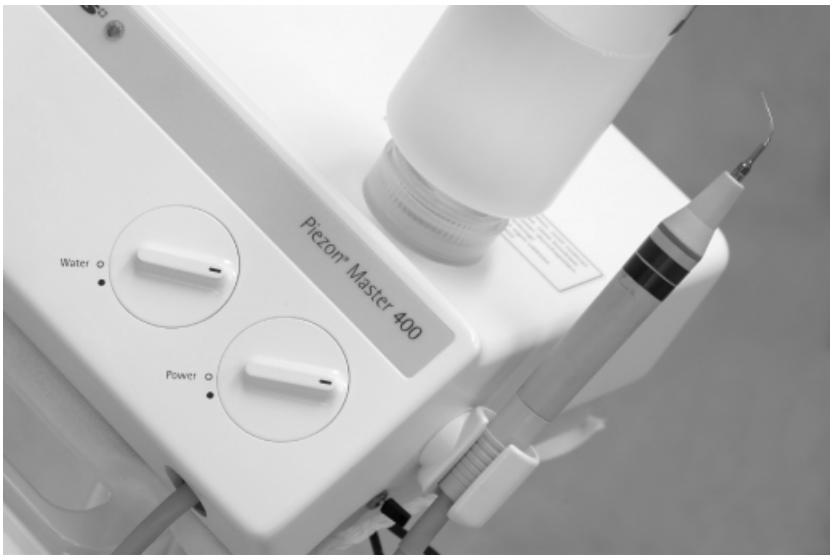

*Fig. 1. P*erio-slim tip (PS-tip) mounted in the ultrasonic scaler (Piezo Master 400, EMS®), with power and supply of coolant to moderate setting (2 o'clock position).

The use of the HVE and the CDS was randomly assigned within each patient. For both types of suction, regular, commercially available, disposable tubes were used: a canula of 8.0 mm in diameter with a suction flow of 6.0 l/min for HVE and a canula, 3.3 mm in diameter with a suction flow of 1.1 l/min for CDS (Fig. 2). The HVE was handled by an assistant. The CDS was used without an assistant: this tube was placed in the corner of the mouth.

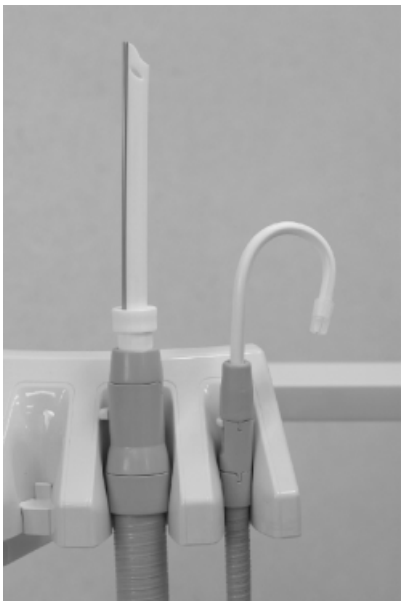

Fig. 2. Regular, commercially available, disposable tubes. For high volume evacuation (HVE), a canula of 8.0 mm in diameter with a suction flow of 6.0 l/min and for conventional dental suction (CDS), a canula of 3.3 mm in diameter with a suction flow of 1.1 l/min.

Sampling procedure

To assess the baseline air contamination, the operatory was left unused and locked for 15 h before each treatment. For gravimetric settling of airborne bacteria, Petri dishes of 11 cm in diameter were used to collect the samples. At the start of each treatment session, two plates were placed in the middle the operatory and exposed to the air for 10 min to measure baseline air contamination. During this procedure, the room was left unoccupied. Next, the patient, the dentist and assistant entered the room to prepare for the treatment. At the start of the actual treatment, four Petri dishes were exposed. One set of two plates was placed on a tray table over the patients chest, at a distance of approximately 40 cm away from the patients mouth, in an area that can be classified as most prone to be contaminated. These two plates, one for aerobic and one for anaerobic incubation, were

Table 1. Mean number colony forming units presented by method of suction (conventional dental suction, CDS, or high volume evacuation, HVE), during an ultrasonic scaling of untreated patients with periodontitis as assessed by gravimetric settling

	Before treatment	40 cm, t = 0–5 min	40 cm, t = 20–25 min	40 cm, t = 0–5+20–25 min	150 cm, t = 0–20 min	150 cm, t = 20–40 min	150 cm, t = 0–40 min
Total							
HVE	0.2 (0.4)	0.4 (0.7)	1.6 (1.3)	2.0 (1.4)	5.4 (8.3)	2.7 (3.2)	8.1 (11.3)
P-value	0.21	0.11	0.84	0.24	0.33	0.56	0.38
CDS	0.6 (0.7)	2.5 (2.9)	1.8 (1.6)	4.3 (3.5)	6.3 (5.9)	4.0 (4.1)	10.3 (9.5)
Aerobic							
HVE	0.0 (0.0)	0.0 (0.0)	0.9 (1.3)	0.9 (1.3)	3.4 (5.0)	1.7 (2.4)	5.1 (7.2)
P-value	0.02	0.02	0.02	0.84	0.92	0.40	0.73
CDS	0.5 (0.5)	1.0 (1.2)	0.0 (0.0)	1.0 (1.2)	2.9 (3.4)	2.5 (2.6)	5.4 (5.8)
Anaerobic							
HVE	0.2 (0.4)	0.4 (0.7)	0.7 (1.0)	1.1 (1.2)	2.0 (3.5)	1.0 (1.0)	3.0 (4.3)
P-value	0.61	0.30	0.11	0.08	0.06	0.69	0.12
CDS	0.1 (0.4)	1.5 (2.1)	1.8 (1.6)	3.3 (2.7)	3.4 (2.9)	1.5 (1.7)	4.9 (4.2)

exposed to the air for 5 min (Fig. 3). Another set of two Petri dishes was placed on a cart approximately 150 cm away from the patient's mouth, next to the wall, behind the patient and the dentist, at a height of approximately 100 cm, in an area that can be classified as more protected. These plates were exposed to the air for 20 min.

Right after these 20 min, another set of four Petri dishes was exposed, following the same procedure:

- two plates at 40 cm for 5 min and
- two plates at 150 cm for 20 min.

Subsequently, the same procedure was repeated while treating a new set of teeth for another 20 min sampling the air according to the procedure as described above.

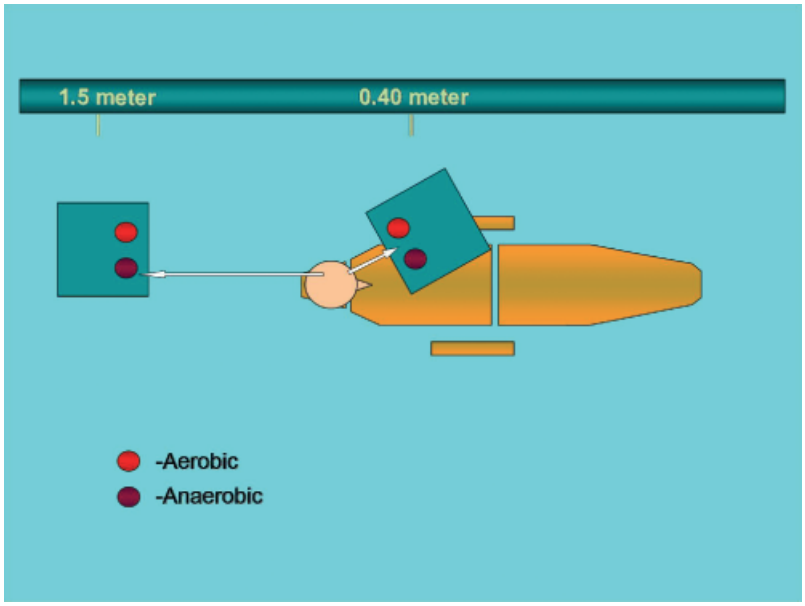

Fig. 3. Map of the dental operatory. One set of two plates at a distance of approximately 40 cm and one set of two plates approximately 150 cm away from the patient's mouth.

Microbiological analysis

The Petri dishes contained brain hart infusion agar, with 5% horse blood added. Each pair of dishes was split, to culture one of them aerobically and one anaerobically. Both were incubated at 36.7 °C. The aerobic culturing was performed for 3 days and the anaerobic culturing for 7 days. After this period, colonies were counted to assess the number of colony forming units (CFU). Mean numbers of CFU were calculated for anaerobic, aerobic and total counts.

Data analysis

Mann–Whitney tests were used to test for differences between both types of suction. Wilcoxon tests were used to test for differences between first and second sampling periods and between numbers of CFU of anaerobic and aerobic bacteria. Bonferoni corrections for multiple testing were applied as appropriate. Data were recalculated to obtain estimators for the whole duration of the therapy and to determine values suitable for comparing the data to the scale of the Air Microbial Index (AMI) (number of CFU = 0–25: good; 26–50: mediocre: 51–75: bad: >75: very bad).

Results

In Table 1, the total number of CFU, sampled at each location for each sampling cycle is shown. Before treatment, after having closed the operatory for 15 h, almost no cultivable airborne microorganisms are present. The mean total number of CFU was 0.2 before the use of the high-volume evacuator and 0.6 before the use of conventional suction, respectively. While using the high-volume evacuator, the total number of CFU at the 40 cm distance was 0.4 for the first sampling period and 1.6 for the second period. Using conventional suction, the total number of CFU was 2.5 and 1.8, for the first and the second period, respectively. No differences could be found between the two methods of suction at this distance. At the 150 cm distance, a mean CFU of 5.4 was found for the first sampling period and 2.7 for the second using the high-volume evacuator and they were 6.3 and 4.0 while using the conventional device. No differences were found between the two types of suction.

The distribution between the anaerobic and aerobic counts is also shown in

Table 1. Total numbers of CFU seem to be composed of comparable proportions of aerobic and anaerobic microorganisms. No differences were found between the two types of microorganisms.

Discussion

The present study was initiated to evaluate the aerosol production using a piezoelectric ultrasonic scaling device, which was recently developed and at present widely used, for performing initial treatment. As a parameter, two different methods of suctioning were compared. Table 2 shows values recalculated to fit these criteria. The first layer of the table tries to interpret the differences in total microbial pollution for the two distances as they were registered over a total 40 min treatment session. As is shown, the number of CFU seems to be comparable for the two distances when using the high-volume device. With the conventional suction, the number of airborne bacteria tends to be larger at the 40 cm distance. The second layer shows data extrapolated to a 60 min sampling time, the time originally used to take samples to assess the AMI. Values now range between 12.0 and 25.5. For the interpretation of AMI values, the reference values suggested by Pitzurra et al. (1980) are the following. The condition is considered good when the number of CFU ranges from 0 to 25. In the range from 26 to 50 the condition is mediocre. From 51 to 75 CFU, the condition is defined as bad and with scores higher than 75, it is regarded as very bad.

Before starting treatment, almost no bacterial contamination of the air in the dental operatory was found. This is in contrast to the results found by Legnani et al. (1994). That experiment took place in a university operatory normally used for 4 h a day, 5 days a week, after 20 h of environmental rest. They assessed the preoperative condition of the air as decidedly mediocre. They also found a large increase of bacterial counts during the therapy session. Their data show values of over 100 times larger than the present results, where the position of the Petri dishes was comparable to the more distant position of the dishes in the present study.

Table 2. Calculated number of colony forming units by method of suction

Total treatment time	HVE	CDS
1.50 m, 0–40 min	8.0	17.0
0.40 m, 0–40 min	8.1	10.3
AMI values		
1.50 m, 0–60 min	12.0	25.5
0.40 m, 0–60 min	12.2	15.5

HVE, high-volume evacuation; CDS, conventional dental suction.

When making an effort to compare the present results with other studies on microbial air contamination due to the use of ultrasonic scalers, a broad variety of sampling techniques and methods are found in the literature. Studies that use gravimetric settlement as a sampling technique and that supply enough information about instrumentation time, sampling time and distance of sampling to the work field, suggest results that range from about half of the values of the present study up to 6 × that magnitude and in most studies tend to be higher (Williams et al. 1970, Holbrook et al. 1978, Bentley et al. 1994, King et al. 1997). All studies use magnetostrictive devices. Information given on the method of suction is limited. For this effort, the present data as assessed with the CDS were taken into account. The large variance in design and techniques of the studies gives rise to a cautious interpretation when comparing these data. However, data in the present study seem to agree with the available literature.

The results of the present study showed no differences when different methods of suction were used. This might indicate that the amount of aerosol with small particle size, able to carry bacteria over a larger distance, as produced by the present piezoelectric device, is relatively limited. This may be different for magnetostrictive devices. The tip in a piezoelectric device shows a to & fro movement in a single plane that may be imagined through the handle and the end of the tip. In a magnetostrictive device, the movement of the tip is more ellipsoidal, due to the different powering mechanism (Petersilka & Flemmig 1999). This difference in movement may also explain why the above-mentioned trend of the present data is lower than in other studies.

However, high-volume evacuators have been shown to be effective in minimizing the danger of contaminated aerosols (Harrel et al. 1998). The present data do not disagree with those findings.

In conclusion, with reference to the AMI the operatory atmosphere could be considered in a good condition during 40 min of continuous use of the ultrasonic scaler in combination with both the high-volume evacuator and the CDS. The present results show that atmospheric microbial contamination does not appear to be a major problem when using a piezoelectric ultrasonic scaler. The use of a high-volume evacuator may, however, help to minimize risks of air microbial contamination.

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