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Evaluation of Airborne Bacterial Contamination During Procedures in Oral Surgery Clinic

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ABSTRACT

Aerosols arising out of oral surgical procedures are composed of saliva, nasopharyngeal secretion, organic particle and blood. This aerosol may act as a vehicle for various bacteria and thus can become a source of infection. An evaluation of airborne bacterial contamination has been done to assess the bacterial composition of aerosols that are formed during surgical procedures. Thirty patients, of both gender in the age group of 18 to 25 years with mandibular impacted third molar who visited the Department of Oral and maxillofacial Surgery, in our center were selected for the study. Microbiological analysis of air borne contamination Petri dishes containing blood agar. Wilcoxon signed rank test, Friedman test using software SPSS version 17.0 Alpha hemolytic streptococci are the predominant bacterium seen in all the 30 surgeries followed by other bacteria. Bacteria grown on the blood agar plate near the surgeon and the patient are the same however Enterococcus faecalis and Escherichia coli are not grown in the agar plate kept near the instrument trolley. The dental surgery clinic should have proper air conditioning system with air filters that can reduce circulating aerosols and it should be made mandatory to find out whether the patient is in active stage of any infection before oral surgical procedure.

Key words: Aerosol, bacteria, minor oral surgery, infection

INTRODUCTION

Infection hazards are one of the main concern in Oral Surgical practice[1]. Direct and indirect contact can transmit many infections. Droplets, aerosols, and instruments may become a source of infection in the clinical environment[2]. Various studies have shown that the airborne transmission of microorganisms in the dental units is quite common[3, 4]. Various dental personnel like dentists, nurses, and other paramedical staffs are at risk of being infected with diseases and also in spreading the disease to the patients[5].

Aerosol's bacterial content differs based on the type of dental procedure performed and the nature of the patient's oral microflora[6]. Aerosols in the dental clinic constitute saliva, nasopharyngeal secretion, organic particle and blood[7]. This aerosol may act as a vehicle for various bacteria and thus can become a source of infection[8]. The nature and diameter of aerosol will differ before, during and after a dental procedure[9]. Aerosol less than 50 microns will be airborne for some time before they settle on any surface[10]. Aerosols may form a direct source of infection and may enter the respiratory tract[11]. Aerosols that are more than 50-micron diameter called as splatter settles more quickly on

the surface. Splatter is the primary source of surface contamination[12]. Thus, the practice of infection control will be based on proper assessment of the nature of aerosol in a particular dental unit at the various point of time. It is imperative to evaluate the aerosol qualitatively and quantitatively for the presence of bacteria to assess the risk of infection. Strategy for infection control should be evolved using appropriate methods to address this problem.

The procedures involved in oral surgery have high chances of creating contamination of aerosols and blood borne pathogens[13]. In the present study, an evaluation has been done in minor oral surgical practice to assess the bacterial composition of aerosols formed during surgical procedures.

MATERIALS AND METHODS

Our study was designed to screen aerosol for the presence of bacteria by plate exposure method produced during the surgical removal of mandibular impacted third molar. Institute Ethics Committee Clearance obtained before the start of the study.

Thirty patients, of both gender in the age group of 18 to 25 years with mandibular impacted third molar who visited the Department of Oral and Maxillofacial Surgery, were selected for the study. An informed consent was obtained from all the patients in a prescribed format the time of study.

Microbiological analysis of air borne contamination

Surgery performed in a closed room with dimension of 5.5m x 5.5m x 5m. The room isolated for 15 hours before each surgery. Two Petri dishes containing blood agar were exposed for 20 minutes before each surgery to air to measure baseline microbial air pollution.

Blood agar plates exposed at patient's chest, near surgeon, near attendant and instrument trolley at the beginning of each surgery. They were kept open for 20 minutes in total including the time of the surgical procedure.

The standard surgical procedure using surgical bur and handpiece were performed to remove the impacted tooth.

After surgery, the plates were incubated at under aerobic condition at 37°C for 24 hours. The number of colonies counted and data presented as Colony Forming Units (CFU)/ cm2. The bacteria that were isolated were identified based on morphological and biochemical characteristics.

The isolated bacteria were gram stained to study its morphology. Color, pigment production, and hemolysis pattern in blood agar helps in identification of the colonies. Then the bacteria were subjected to various biochemical reactions like oxidase, catalase, coagulase, IMViC, and carbohydrate fermentation to identify them to the level of species.

Statistical analysis

The mean values were compared for its significant difference between different groups and control by Wilcoxon signed rank test followed by Friedman test by using software SPSS version 20.0

RESULTS

Bacteria isolated from air after surgery

Blood agar plate kept near the patient containing bacterial growth is shown in Table 1. Alpha-hemolytic streptococci are the predominant bacterium seen in all the 30 surgeries followed by other bacteria. Coagulase-negative Staphylococcus is another predominant bacterium grown in 22 cases. The isolated bacterium from 12 cases is *Staphylococcus aureus* and *Enterococcus faecalis* from 2 cases. 8 cases showed the presence of Pseudomonas spp. and 2 cases showed *Escherichia coli*.

Blood agar plate placed near the surgeon containing bacterial growth represented in Table 2. The results are almost same as that of bacteria grown near the patient except for its frequency.

Table 3 presents the bacteria from blood agar plate kept near the instrument trolley. Again the alpha hemolytic streptococci are the

predominant bacteria. However, Enterococcus faecalis and Escherichia coli are not grown.

Bacteria grown on the agar plate kept near the attendant (Table 4) also presented the similar results with alpha hemolytic streptococci being the predominant bacteria.

Bacterial density

As the data set did not fall into a normal curve, Wilcoxon signed-rank test was performed to find the difference in the mean values before and after surgery, and results tabulated in Table 6. From the table, it is evident that the difference in mean value is statistically significant ($p<0.001$).

Table 1: Bacteria grown on the blood agar plate kept near patient

S.No.	Bacteria	Frequency (N=30 surgeries)
1	Alpha haemolytic streptococci	30 (100%)
2	Coagulase negative staphylococci	22 (73.3%)
3	*Staphylococcus aureus*	12 (40%)
4	*Enterococcus faecalis*	2 (6.6%)
5	Pseudomonas spp.	8 (26.7%)
6	*Escherichia coli*	2 (6.6%)

Table 2: Bacteria grown on the blood agar plate kept near surgeon

S.No.	Bacteria	Frequency (N=30 surgeries)
1	Alpha haemolytic streptococci	30 (100%)
2	Coagulase negative staphylococci	23 (77%)
3	*Staphylococcus aureus*	10 (33%)
4	*Enterococcus faecalis*	1 (3.3%)
5	Pseudomonas spp.	10 (33%)
6	*Escherichia coli*	1 (3.3%)

Table 3: Bacteria grown on the blood agar plate kept near instrument trolley

S.No.	Bacteria	Frequency (N=30 surgeries)
1	Alpha haemolytic streptococci	30 (100%)
2	Coagulase negative staphylococci	17 (57%)
3	*Staphylococcus aureus*	6 (20%)
4	Pseudomonas spp.	2 (6.6%)

Table 4: Bacteria grown on the blood agar plate kept near attendant

S.No.	Bacteria	Frequency (N=30 surgeries)
1	Alpha haemolytic streptococci	30 (100%)
2	Coagulase negative staphylococci	12 (40%)
3	*Staphylococcus aureus*	3 (10%)
4	Pseudomonas spp.	3 (10%)
5	*Escherichia coli*	1 (3.3%)

Table 5: Bacterial density before and after surgery expressed in CFU/cm²

	Before surgery	After surgery			
		Patient	Surgeon	Attendant	Instruments trolley
Mean (CFU/cm²)	0.016±0.017	0.433±0.194	0.468±0.218	0.448±0.236	0.383±0.168

Table 6: Test statistics obtained by Wilcoxon signed-rank test

Site	Asymp. Sig.-2-tailed(P value)	Z value
Patient	0.00	-4.70
Surgeon	0.00	-4.70
Attendant	0.00	-4.70
Trolley	0.00	-4.78

Table 7: Mean ranks of means obtained from different sites

Site	Mean rank
Patient	2.48
Surgeon	3.04
Attendant	2.46
Trolley	2.02

Table 8: Test statistics of Friedman test

N	30
Chi-Square	8.88
df	3
Asymp. Sig.	.03

Friedman test was used to find whether there is any statistically significant difference existing between the mean value of the bacterial density of air at the different site after surgery. Table 7 gives mean ranks of means obtained from various sites.

There was a statistically significant difference between the mean values of bacterial density at different sites, χ 2(3) = 8.88, p = 0.03.

Post hoc analysis with Wilcoxon signed-rank tests on the various combinations of related groups were conducted to examine whether the differences occur. Bonferroni correction applied, resulting in a new significance level set at $p < 0.008$. Table 9 shows the test statistics thus obtained. From the table it is found that only the difference in bacterial density between the surgeon and instruments trolley is statistically significant ($p < 0.008$).

DISCUSSION

Table 5 depicts the mean bacterial density expressed in CFU/cm2 before and after surgery. From the table, it is evident that the average values are high in the plates exposed after surgery.

Table 9: Test statistics of Post hoc analysis with Wilcoxon signed-rank tests

	Patient-Surgeon	Patient-attendant	Patient-instrument trolley	Attendant-instrument trolley	Surgeon-attendant	Surgeon-instruments trolley
Z	-2.016	-1.062	-2.611	-1.346	-1.483	-3.391
Asymp. Sig.-2-tailed(P value)	.044	.288	.009	.178	.138	.001

The present work has clearly indicated that the bacterial density of air is high after minor oral surgical procedures. Many studies have shown that there is an increase in bacterial contamination during various dental procedures[14, 15]. The present study has confirmed the same. There is an evidence of aerosolised floating blood mist during minor oral surgical procedures[16], and this may be the reason for an increased bacterial contamination. These aerosols can be a potential source of transmission of infectious diseases[17].

The aerosols produced during dental procedures contain bacteria, virus, and fungi[18]. In a study conducted by Grenier, it was found that microflora of air contains Staphylococcus epidermidis – 37.1% of total bacteria, Micrococcus spp. – 32.6%, nondiphterial corynebacteria – 28.2%, Staphylococcus aureus – 0.6%, Pseudomonas spp. – 0.6%, and fungi – 0.9%. The presence of opportunistic microorganisms (Staphylococcus epidermidis, non-diphtherial corynebacteria, Pseudomonas spp.) is also significant[19]. Most of the bacteria isolated are typical for the oral cavity. In another study conducted by Osorio et al., showed that Streptococcus and Staphylococcus bacteria are prevalent in the air of a dental surgery room[13]. Nowadays the prevalence of blood-borne viruses have increased in the places of oral and maxillofacial surgery clinics. It has become a place of risk for their transmission of infections from patients to the oral surgeon[20]. In the present study, we were able to isolate coagulase-negative staphylococci along with Staphylococcus aureus. In some cases Pseudomonas spp, Enterococcus faecalis, and Escherichia coli were also isolated.

Methods to control aerosols are not difficult and involves only less expenditure[21]. They contain two important steps. The first is to control the aerosol production, and the next is to eliminate the aerosol from the environment before it contaminates the surroundings[22]. An important method to reduce the bacterial count in the aerosol is to use pre-procedural anti-microbial mouth rinse. Use of a 0.12% of chlorhexidine mouthwash before the dental procedure has significantly brought down the bacterial count in the aerosol[23].

The routine way of protection from aerosol contamination in operating room is to use protective barriers like wearing a mask, gloves, and protective eyewear[24]. However, several studies have shown that mask is not a foolproof method of preventing the entry of aerosol, especially the droplet nuclei. The droplet nuclei have chances of entering through the pores of the mask and also the through its periphery and may reach the respiratory tract[25]. Thus, it has become imperative to eliminate the aerosol contamination after the dental procedure.

The dental operative surgery clinic should have proper air conditioning system with air filters that can reduce circulating aerosols[26]. Another important way to manage the airborne contamination is the use of a high-efficiency particulate air (HEPA) filter. Ultraviolet ray bulbs can also be in the operating room. The use of high volume evacuator (HVE) is also shown to reduce the airborne contamination by more than 90% [27-30].

Many countries including India have not set any standards for the permissible airborne bacterial load. However, countries like the United Kingdom have set a bacterial limit of 35 CFU/M3 for an empty surgical theater and 180 CFU/M3 for an active surgical theater.

CONCLUSION

The findings of the present study have demonstrated that the bacterial load of the surgical room after post operation exceeds the permissible limits. Further, it has also shown the presence of few pathogenic bacteria like S.aureus, E.faecalis, and E.coli. Thus, our study reflects the possibility of acquiring the nosocomial infection to the patients and Surgeon. Hence, it is mandatory to sterilize the surgical room in between two surgeries.

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