Received 7 November 2006; Accepted 27 January 2007

Contamination of Dental Unit Water and Air Outlets Following Use of Clean Head System and Conventional Handpieces

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Abstract

Background and aims. Dental handpiece is a source of contamination because it is in constant touch with the oral cavity. Sterilization does not seem to be sufficient to prevent penetration of microorganisms into air and water lines of the unit, because negative pressure developed by valves (which are placed in water outlets) and post shut-off inertial rotation of handpiece result in water and debris being sucked into air and water outlets of dental unit. The aim of this study was to compare dental unit contamination following use of clean head system handpieces and conventional handpieces.

Materials and methods. Twenty-two dental units in the Department of Pediatric Dentistry in Shahid Beheshti Faculty of Dentistry were used for the purpose of this study. A 1.5×10^8 cfu/mm^3 concentration of *Staphylococcus epidermis* (SE) was used to contaminate the air and water outlets of dental units. Ten clean head system handpieces and 10 conventional handpieces were used for 30 seconds in the above-mentioned suspension. Microbial samples were collected from the air and water lines. Culturing and colony counting procedures were carried out. Data was analyzed by t-test; a value of $p<0.01$ was considered significant.

Results. Results demonstrated a significantly lower SE contamination in water outlets following the use of clean head system ($p<0.01$).

Conclusion. A lower tendency of clean head system handpieces to transmit SE compared to conventional system makes them a better choice for infection control.

Key words: **Cross-infection, dental handpiece, infection control, *Staphylococcus epidermis*.**

Introduction

Development of new methods and approaches in infection control has been one of the most interesting fields in dentistry in recent years.[1]

Infection control is a definite necessity in dental treatments and is of greater importance in pediatric dentistry because of physiological and immunological sensitivity of children.[2]

Dental handpieces are frequently used in a pediatric office. Being in touch with microbial flora of mouth makes them a source of contamination, so it is mandatory to replace and sterilize them.[3] It seems that sterilization of handpieces and burs is not sufficient because it does not prevent penetration of micro-organisms into air and water lines of dental unit. Upper respiratory system infections, bacterial and viral dermal infections and many other diseases happen as a consequence of cross-infection, so dental unit air and water lines should be considered a possible source for cross-infection. Two mechanisms contribute to the contamination of dental unit air and water lines:

1) When the handpiece shuts down, the remaining water in the water line tends to flow into the patient's mouth; therefore, retraction valves are placed in dental unit water lines to produce a negative pressure and suck back the remaining water. This mechanism is often accompanied with debris aspiration, leading to the air and water lines contamination.[4]

2) Post shut-off inertial rotation of dental handpieces and burs is another contributing factor for air and water line contamination by producing a negative pressure.[5]

Disinfection of dental unit tank after each session has been suggested as a possible solution but it is time-consuming and not cost-effective. In some dental clinics tank disinfection is not possible because of one-way air and water lines system.[6]

Clean head handpieces have been introduced into dentistry by NSK. The manufacturer claims these handpieces have some specific valves to inhibit the air and water lines contamination through the two above-mentioned mechanisms.[7]

The current study was conducted to compare the air and water lines contamination of dental units following use of clean head system handpieces and conventional handpieces.

Materials and Methods

All 25 dental units of the Department of Pediatric Dentistry in Shahid Beheshti Faculty of Dentistry were used for the purpose of this study. The research process began on the final day of the semester and continued during the holidays between the two semesters so as not to disturb the routine daily program of the department. All the units were first dried with a sterile towel just after the daily work. In the next step the units were screened for a previous contamination with *Staphylococcus epidermis* (SE), which is not pathogenic, in order to eliminate such units from the main stage of the experiment as follows:

a) All the handpieces were detached.
b) Microbial samples were collected from air and water lines of all the units by means of a sterile loop ounce next to a torch. Sampling duration was 25 seconds for each water or air outlet.
c) Samples were then transferred to blood agar (containing basic proteins, low concentrations of carbohydrates, sodium chloride, agar, sheep blood) for culturing. After a 24-hour period of incubation at 37˚C, microbiological screening tests(coagulation test ,catalase test, hemolytic test)were carried out to separate *Staphylococcus epidermis* (SE) and plates with 10 colony counts and less were identified as non-contaminated with SE and the related units were selected for the next step of the experiment(20 units). Others (5 units) were excluded in order to avoid technical bias.

In the main part of the experiment a 1.5×10^8 cfu/mm^3 concentration of SE suspension (matched with Mc Farland standard tubes[8]) was used to contaminate the air and water outlets of the unit. Ten clean head system handpieces (group A) and 10 conventional NSK handpieces (group B) with an 0.8 fissure bur were used for 30

seconds in the suspension 3 times with 10-second intervals. The water spray was adjusted for all the units in the middle, and then microbial samples were collected for culturing as explained in the primary stage. After 24 hours of incubation at 37˚C, microbiological screening tests for SE and colony count were carried out. Plates with 100 colonies and more were regarded as highly contaminated plates. If the colony count was between 10 and 100, the plate was considered moderately contaminated. Ten colonies and less than that were defined as mildly contaminated.

In the last stage of the study all air and water outlets were disinfected with 2.5% sodium hypochlorite for 5 minutes. Sampling and culturing procedures were carried out to ensure SE elimination for future routine dental use. T-test was used for data analysis and a value of $p<0.01$ was considered significant.

Results

Tables 1 and 2 depict the results of colony counts for groups A and B. A quick glance at these two tables reveals a lower colony count in both air and water outlets in group A in comparison with group B. Figure 1 depicts this comparison better. There is a significant difference ($p<0.01$) in water line contamination for SE between the two groups. The mean number of colonies counted in air outlets for group A were lower than that in group B; however, t-test did not reveal statistically significant differences ($p>0.01$). Tables 3 and 4 illustrate the distribution of results in three groups (highly, moderately and mildly contaminated). Figure 2 shows the comparison of highly, moderately and mildly contaminated subgroups between groups A and B.

Table 1. Results of colony count in plates in group A

sample no.	1	2	3	4	5	6	7	8	9	10
water outlet	25	10	5	10	0	0	10	15	0	0
air outlet	0	0	0	3	0	0	0	0	0	0

Table 2. Results of colony count in plates in group B

sample no.	1	2	3	4	5	6	7	8	9	10
water outlet	250	170	200	150	260	310	210	180	210	290
air outlet	11	7	5	0	0	5	0	8	4	0

Table 3. Contamination rate in plates in group A

low: cfu<10 and 10
medium: 10<cfu<100
high: 100 and more than 100

	low	medium	high
water outlet	5	5	0
air outlet	10	0	0

Table 4. Contamination rate in plates in group B

low: cfu<10 and 10
medium: 10<cfu<100
high: 100 and more than 100

	low	medium	high
water outlet	0	0	10
air outlet	9	1	0

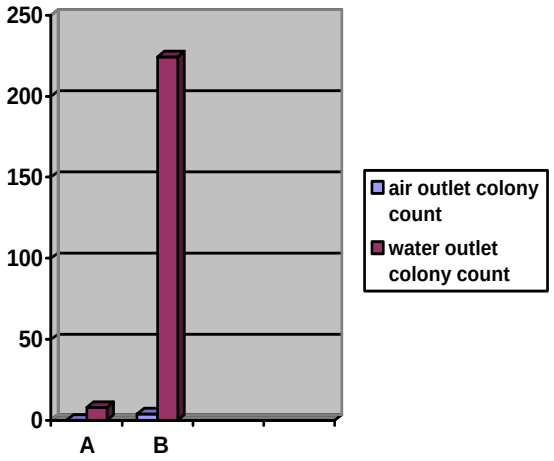

Figure 1. Comparison of mean total colony count in air and water outlets between group A and group B.

As demonstrated in Tables 3 and 4, 90% of the plates in group B had a low contamination rate in the air outlets and just 10% had medium contamination rate. In group A, all the samples had low contamination rate; however, none of the differences were statistically significant ($p>0.01$). All the samples in group B had a high contamination rate in water lines. In group A half of the samples had low contamination rates; the other half had medium contamination rates. The differences between the two groups in three subgroups of high, medium and low contamination were statistically significant ($p<0.01$). All the samples collected in the last stage demonstrated low contamination rate after culturing and colony counting.

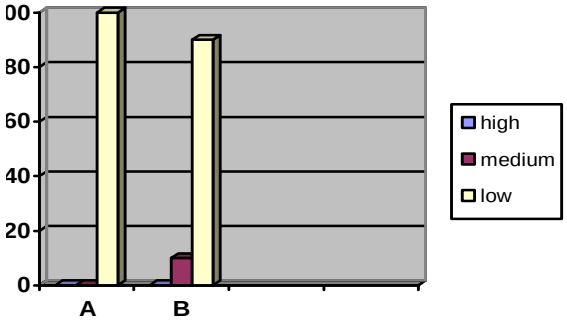

Figure 2-a

Figure 2. Comparison of the two groups in three subgroups (low, medium and high contamination) (in percentage); 2-a: air outlet; 2-b: water outlet.

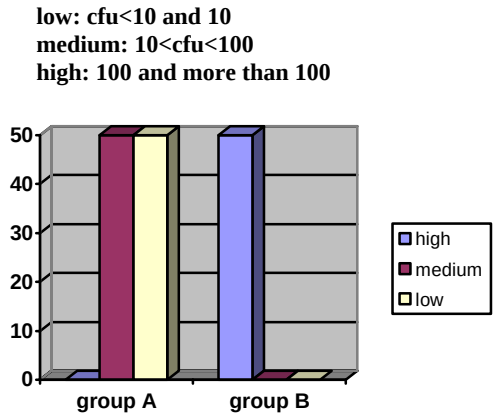

Figure 2-b

Discussion

The present study demonstrated that the mean total count of *Staphylococcus epidermis* following the use of clean head handpieces was lower in comparison to the use of conventional non-clean head handpieces. The difference was significant in water lines ($p<0.01$) but not significant in air outlets ($p>0.01$). These findings are similar to the results reported by Yamaga and Bagga.[5, 8]

As previously mentioned, air outlet contamination happens as a result of post shut-off inertial rotation of handpiece. According to our findings contamination rates were low in all the samples taken from air outlets, so air outlet of handpiece is not a main contributing factor in cross-infection.

In water outlets post shut-off inertial rotation of handpiece and retraction valves take part in the contamination transmission process. Decreased contamination rate in group A, in comparison to group B, demonstrated that clean head system (which inhibits the retraction valves' suck-back effect) prevented handpiece water outlet contamination.

The present study demonstrated that non-clean head system transmits the infection through water lines 28 times more than clean head handpieces (Figure 1). Yamaga reported that non-clean head system transmits the contamination 1000 times more.[5] This proportion is 4000 in Bagga's research.[8] The differences might be attributed to different bacterial types used in these three studies.

Air outlet contamination in the present study was not high in groups A and B; therefore, we believe the two previously mentioned mechanisms of air and water outlet contamination play a major role in the liquid phase.

Conclusion

The results of the current study reveal that clean head system handpieces transmit less contamination through water outlets of dental units; however, a simple method of flushing for 3 minutes and disinfecting with sodium hypochlorite for 5 minutes is recommended to decrease the bacterial count in air and water outlets.

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