The effect of rubber dam on atmospheric bacterial aerosols during restorative dentistry

Suhail H. Al-Amad*, Manal A. Awad, Faraj M. Edher, Khalil Shahramian, Tarek A. Omran

College of Dental Medicine, University of Sharjah, PO Box 27272, Sharjah, United Arab Emirates

Received 24 November 2015; received in revised form 14 March 2016; accepted 3 April 2016

Summary Rotary dental instruments generate atmospheric aerosols that settle on various surfaces, including the dentist’s head. The aim of this study was to quantitatively assess bacterial contamination of the dentist’s head and to evaluate whether it is affected by using a rubber dam. Senior dental students (n = 52) were asked to wear autoclaved headscarves as collection media while performing restorative dental treatment with and without a rubber dam. Four points from each headscarf were swabbed for bacterial culture after 30 min of operative work. Bacterial contamination was quantified by counting the colony-forming units. Regardless of the collection point, using a rubber dam was associated with more bacterial colony-forming units than not using a rubber dam (P = 0.009). Despite its clinical value, the rubber dam seems to result in significantly higher aerosol levels on various areas of the dentist’s head, requiring that dentists cover their heads with suitable protective wear.

© 2016 King Saud Bin Abdulaziz University for Health Sciences. Published by Elsevier Limited. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

Dentistry is a clinical profession that is associated with biological, chemical and physical hazards. The surgical nature of clinical dental practice, and the dentist’s position in close proximity to the patient, put the dentist at risk of microbial infections, which can be transmitted by direct contact or by atmospheric aerosols.
Several studies have demonstrated microbiological contamination of various clinical surfaces in hospitals and dental clinics [1–5]. Clinician’s attire, such as scrubs and white coats, were found to harbor a plethora of bacterial species at high quantities [6–8]. Pathogenicity of microorganisms detected on clinical surfaces ranged in their severity; with some being the cause of serious illnesses, such as measles and tuberculosis [9].

To minimize exposure to potentially pathogenic microorganisms, the Center for Disease Control and Prevention (CDC) recommends that all dental healthcare providers (DHCPs) use barriers to cover clinical surfaces as well as personal protective equipment (PPE) (gloves, masks, goggles and gowns) to cover their skin and mucous membranes of eyes, nose and mouth when performing dental treatments. The CDC also recommends the use of high velocity suction and rubber dams to reduce the aerosols generated during rotatory dental procedures [10].

The rubber dam is a disposable rubber sheet that is stretched around the treated tooth/teeth, isolating the treatment zone from saliva. The use of a rubber dam during restorative and endodontic treatments is considered the standard of care in most dental care-providing clinics and hospitals. Its use has been associated with higher rates of dental treatment success [11]. Additionally, Cochran et al. and Samaranayake et al., in two separate studies, observed a significant reduction in bacterial atmospheric contamination when rubber dams were used [12,13].

Nevertheless, the amount of bacteria-contaminated spatter accumulating onto the clinician’s head, with and without the use of a rubber dam, has not been previously investigated. The objective of this study was to determine the effect of using a rubber dam on the amount of bacteria cultured from various regions of the clinician’s head during routine restorative dental treatment.

Materials and methods

Sample and setting

Female dental students in their fourth and fifth years, who would customarily wear headscarves, were invited to participate in this study. The study took place at the University Dental Hospital Sharjah (UDHS) in the United Arab Emirates during the 2013/2014 academic year. UDHS is a 114-dental chair ambulatory hospital that is owned and administered by the College of Dental Medicine at the University of Sharjah. The hospital was inaugurated in 2011 to provide advanced dental clinical training at the graduate and post-graduate levels.

Students who consented to participate (n = 52) were randomly assigned into two equal groups using computer-generated random numbers and then assigned to a dental clinic where they performed a routine restorative dental procedure. To standardize the extent of the dental procedure, only dental cavity preparations on posterior teeth that were already planned for the patients were included. A colleague from the same group was assigned to assist each student by holding the surgical suction tube throughout the clinical procedure. All students wore similar PPE, consisting of a disposable apron, mask, gloves and plastic goggles. Half the sample (n = 26) was asked to perform this procedure while a rubber dam was placed over the tooth that was being treated, while the other half (n = 26) performed similar procedures without a rubber dam. This study was approved by the UDHS Executive Director and was exempted from full review by the Research Ethics Committee as it was a clinical audit.

Microbiological assessment

Fifty-two unused cotton-polyester scarves were packed in plastic pouches and sterilized by autoclave with the temperature set at 132 °C for 30 min. In this way, the colony forming unit (CFU) baseline was set to zero. Each scarf was removed from its pouch using clean gloves and the participants donned the scarves immediately before starting the procedures. Students were instructed to wrap the scarves around their head and neck in the same manner as they would normally do with their customary headscarves. They were asked to avoid touching the scarf throughout the duration of the 30-min procedure. Participants were then asked to begin cavity preparation; 30 min into the operative work, participants were asked to pause their work to allow for bacterial swabbing.

Sterile cotton swabs that were moistened with sterile normal saline were used to sample each headscarf. The sterile cotton swabs were passed twice (up and down) over an area measuring approximately 3 cm × 3 cm. Four sampling areas on each headscarf were pre-determined, and the swabbing process was calibrated using a visual guide (Fig. 1). The four sampling areas were as follows: the area overlaying the forehead (designated as point A), the area overlaying the left ear (point B), the area overlaying the submental triangle (point C), and the area overlaying the occiput.
(point D). The swabs were placed in their labeled tubes and transported to the Microbiology Department of the College of Health Sciences, University of Sharjah for culturing. Each swab was immediately streaked onto a marked Petri dish containing Tryptikase Soy Agar. The plates were then aerobically incubated at 37°C for 24 h and the CFUs on each plate were counted and recorded.

Statistical analysis

Data processing and analyses were performed using IBM SPSS/PASW, version 22 (IBM Corp). Comparison between the mean CFU of the four points was performed using analysis of variance (ANOVA). The relationship between rubber dam use, as the independent variable, and the overall CFU for each of the four points was determined using independent t-test. Two-way ANOVA was used to assess the relationship between rubber dam use, the location of each point and the CFU. The level of significance was set at alpha = 0.05.

Results

Fifty-two female students enrolled in this study. During the course of cavity preparation, 2 participants were excluded due to changes in the dental procedure type intra-operatively (from restorative cavity preparation to access opening and inlay preparation) and 3 students had to use a face shield and were dropped out. The final sample consisted of 47 students with 188 collection points (four points for each student). Of those collection points, 16 were outliers in that they were more than three standard deviations above the mean. These 16 outliers were excluded from statistical analysis.

The majority of the outliers (13 collection points) belonged to the rubber dam group. The final sample size was 47 (22 in the rubber dam group and 25 in the non-rubber dam group). The final number of collection points was 172.

Four students (8.5%) had zero CFU values in all collection points. Three of these belonged to the non-rubber dam group. On average, the points in the rubber dam group had more CFUs than the non-rubber dam group, but this difference was not statistically significant (Fig. 2). Table 1 shows the results of one-way analysis of variance; point A (forehead) had significantly more CFUs (mean: 2.19, SD: 3.04) than the three other points ($P = 0.036$). However, two-way analysis of variance showed that using a rubber dam was associated with significantly higher CFUs ($P = 0.009$) (Table 2). In this study, the interaction between rubber dam use and the location of the points was not statistically significant ($P = 0.95$).

Discussion

Several studies have demonstrated a wide spreading of bacteria onto various surfaces in the dental clinic as a result of aerosols generated from dental rotatory instruments [1,4,14,15]. The bacterial contamination was beyond expectations in terms of the total area of contamination and the quantity and pathogenicity of the bacteria. For example, Rautemaa et al. cultured bacteria at areas well beyond the site of aerosol generation (the dental chair) [4], and Decraene et al. found that nearly half of the bacterial species isolated in the atmosphere of a dental clinic were resistant to at least one commonly used antibiotic [5]. These findings demonstrate that pathological bacteria can be
transmitted from the patient’s oral cavity to various surfaces within the dental clinic.

Nejatidanesh et al. indirectly investigated the pattern of splatter onto the dentist’s face using a face shield as the study medium [16]. The aerosols that affect the dentist’s head have not been previously investigated, which is probably because of the inability to perform reproducible swabbing of the head, including the hair, as well as to singly colonize the bacteria generated from dental operative work.

In our study, we overcame this obstacle by using an autoclavable surface (a headscarf) from which the bacteria-contaminated aerosols were swabbed and cultured. This approach allowed us to set the baseline bacterial contamination to zero. Moreover, our sample consisted of female students who normally use headscarves as part of their Islamic dress code. As a result, the students were not hindered by the use of this collection surface (a headscarf) during routine operative dental work.

The use of a rubber dam in clinical practice significantly affects the quality of dental restorations by isolating the dental cavity from saliva and blood, which often results in restoration failure [11,17]. In this clinical audit, we wanted to evaluate whether the use of a rubber dam, with its known advantages, impacts the level of aerosols settling on the clinician’s head during a 30-min restorative dental treatment.

**Figure 2** Descriptive analysis between the four points, with and without using a rubber dam*. There is no difference between individual points whether rubber dam is used or not. P-values are 0.263 (point A); 0.071 (point B); 0.110 (point C); 0.223 (point D).

**Table 1** Relationship between CFU and the points adjusted for rubber dam use.

<table>
<thead>
<tr>
<th>Variables</th>
<th>TYPE III sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points*</td>
<td>35.129</td>
<td>3</td>
<td>11.710</td>
<td>2.598</td>
<td>0.054</td>
</tr>
<tr>
<td>Rubber dam use^b</td>
<td>31.295</td>
<td>1</td>
<td>31.295</td>
<td>6.944</td>
<td>0.009</td>
</tr>
<tr>
<td>Point*Rubber dam use</td>
<td>1.656</td>
<td>3</td>
<td>0.552</td>
<td>.122</td>
<td>0.947</td>
</tr>
</tbody>
</table>

Regardless of the area on the head, CFU was higher when using a rubber dam by comparison to not using a rubber dam.

* Points are: A (above the forehead), B (over the right ear), C (above the submental triangle), D (the occiput).

^b Rubber dam used or not used during operative work.

**Table 2** Assessment of means CFU by points.^a

<table>
<thead>
<tr>
<th>Total</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point A</td>
<td>2.19 (3.04)^a</td>
</tr>
<tr>
<td>Point B</td>
<td>1.66 (1.82)</td>
</tr>
<tr>
<td>Point C</td>
<td>1.01 (1.09)</td>
</tr>
<tr>
<td>Point D</td>
<td>1.81 (2.15)</td>
</tr>
</tbody>
</table>

^a Based on ANOVA.

Point A is significantly different than point C. P-value = 0.036.
For each of the collection points, the average number of colony-forming units (CFU) was higher in the rubber dam group than in the non-rubber dam group (Fig. 2). The difference between the two groups for each point was not statistically significant. However, when an adjustment was made for all collection points, the presence of a rubber dam was associated with significantly more bacteria-containing aerosols based on the CFU counts ($P = 0.009$) (Table 2). Those results indicate that the use of a rubber dam is associated with significantly higher bacterial aerosol levels in spite of its clinical benefits.

Our sample consisted of dental students who have limited clinical experience. This can be considered a limitation to the generalizability of the study findings. Additionally, because the dental procedures were pre-planned according to each patient’s treatment needs, some variables could not be controlled. These include the location of the treated tooth (maxillary or mandibular). Nevertheless, the selection of a homogeneous group of participants who have similar clinical experience (4th and 5th year dental students), the procedure they performed (cavity preparation of a posterior tooth) and the procedure duration (30 min) reduce the heterogeneity and augment standardization. Despite instructing participating students to avoid touching the headscars during the 30-min procedure, artificial contamination cannot be entirely discounted. Accordingly, the values that were calculated as outliers were considered fictitious and were eliminated from all statistical analyses.

Interestingly, we found that it is possible to complete a 30-min dental operative procedure without aerosols landing on the head, particularly when a rubber dam is not used. As the study evaluated students during their clinical training years, it cannot necessarily be generalized to more experienced dentists. Further research is needed to determine if clinical experience affects the aerosol levels that are generated during dental procedures.

Current infection control protocols, which include the use of gloves, masks and goggles, are insufficient to prevent bacterial contamination to the head. Those protocols should be extended to include a disposable head cap whenever rotary dental instruments are used, especially when a rubber dam is applied.

This study quantitatively measured the bacterial aerosols on the head. Future studies are needed to identify the microbiological species as well as their pathogenicity and resistance to antibiotics to precisely determine the health hazards of dental aerosols.

**Funding**

No funding sources.

**Competing interests**

The authors declare that they have no conflicts of interest for any part of this research.

**Ethical approval**

Not required.

**Acknowledgments**

We thank the following clinical investigators who performed the microbiological sampling and incubation (without whom this research would not have been possible): Jihad Al Basha, Shehreya Chaudhry, Dalia El Hefny, Lina Id, and Deema Kawkar. We also thank Associate Professor Ra’ed Abu Odeh and Mr. Said Shahwan for their assistance with the microbiological studies.

**References**


