Efficacy of pre-procedural rinsing in reducing aerosol contamination during dental procedures

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Abstract
Our objective was to determine the efficacy of pre-procedural rinsing with chlorhexidine in reducing bacterial aerosol contamination during use of ultrasonic scaler and high speed air turbine handpiece. Twenty patients, ten each for the two groups who were found to satisfy the inclusion criteria were selected for the study. Four predesignated locations of the dental clinic were chosen to be evaluated for each patient using blood agar plates. Aerosols were collected during treatment procedures for control and experimental quadrants. Results showed that a regimen of 30-seconds pre-procedural rinsing with 0.12% chlorhexidine gluconate before dental procedures consistently reduced colony-forming units than without rinsing due to the ability of antiseptic mouthwash to inhibit microbial growth. There was more aerosol contamination during scaling procedures than during the use of a high speed air turbine handpiece. The conclusion is that chlorhexidine is an effective primary measure in reducing aerosol cross-contamination when using dental devices in a dental set up.

Introduction
The spread of infection has long been considered one of the main concerns of the dental community. Indeed, infectious agents may be transmitted to patients and dental staff via several vectors, including instruments and air. There is a long history of infections being transmitted by an airborne route, and the potential of this route was recognised even before the discovery of specific infectious agents such as bacteria and viruses. Aerosol and splatter are a concern in dentistry because of their potential effects on the health of immunocompromised patients and of dental personnel (Harrel and Molinari, 2004).

The terms 'aerosol' and 'splatter' in the dental environment were used by Mick et al (1965) in his pioneering work on aerobiology. Aerosols were defined as particles less than 50 micrometers in diameter. Particles of this size are small enough to stay airborne for an extended period before they settle on environmental surfaces or enter the respiratory tract. The smaller particles of an aerosol (0.5 to 10μm in diameter) have the potential to penetrate and lodge in the smaller passages of the lungs and are thought to carry the greatest potential for transmitting infections. Splatter was defined as airborne particles larger than 50μm in diameter. Mick et al (1969) stated that these particles behaved in a ballistic manner. This means that these particles or droplets are ejected forcibly from the operating site and are in a trajectory similar to that of a bullet until they contact a surface or fall to the floor. These particles are too large to become suspended in the air and are airborne only briefly.

There are at least three potential sources (Harrel and Molinari, 2004) of airborne contamination during dental treatment: dental instrumentation, saliva and respiratory sources, and the operative site. Because the oral cavity is a part of the oronasal pharynx, it harbours bacteria and viruses from the nose, throat and respiratory tract. Dental plaque, saliva and oral fluids are major sources of these organisms. Any dental procedure that has a potential to aerosolise saliva will cause airborne contamination with organisms from some or all of these sources. Dental handpieces, ultrasonic scalers, air polishing devices and air abrasion units will produce airborne particles by the combined action of water sprays, compressed air, organic particles, such as tissue and tooth dust, and organic fluids, such as blood and saliva from the site where the instrument is used (Harrel et al. 1998; Hu et al. 2001). Hence, the potential for the spread of infection via an almost invisible aerosol must be recognised and minimised or eliminated to the greatest extent feasible within a clinical situation. One of the methods of reducing overall bacterial counts produced during dental procedures is pre-procedural rinsing with a product containing an antimicrobial agent (e.g. chlorhexidine gluconate, essential oils, povidone iodide).

The majority of the documented studies (Cochran et al. 1989; Bentley et al. 1994) have been carried out in isolated dental clinics under stringent aseptic techniques with well maintained high-velocity suction and constant ventilation facilities. There is little data regarding studies done on aerosol contamination by a high speed handpiece, done under a rural dental setting in developing countries with less than optimal facilities. Also, in tropical countries like India the temperature and humidity play an important role in spreading infections in a rural clinical setup (Tang et al. 2006). The present study focused on two potential sources of infection – the high speed handpiece and...
ultrasonic scalers, which are 'the weak link in the chain of sterility'.

The aim was to determine the efficacy of pre-procedural rinsing with chlorhexidine in reducing bacterial aerosol contamination during the use of an ultrasonic scaler and a high speed air turbine handpiece.

Materials and methods

The present study was conducted among patients visiting the Comprehensive Dental Care Centre of the Department of Community Dentistry, TMA Pai Hospital, Udupi, with the study period extended for two months. Ten voluntary participants with a minimum of 20 permanent teeth and a mean plaque score of 1.8 to 3.0 on the Simplified Plaque Index (Fine et al. 1992) were considered for oral prophylaxis, and ten patients with carious cavities requiring restoration were selected for the study with their informed consent. The sample size was based on the study by Logothetis and Martinez-Wells (1995) and on statistical analysis of four samples. Patients with medical conditions contraindicating the use of ultrasonic scalers and high speed air turbine handpieces and those on systemic or topical antibiotics were excluded from the study.

Four predesignated locations in the dental clinic were chosen to be evaluated for each patient using blood agar plates placed at: the operator's chest area, the patient's chest area, and at a distance of 12 and 24 inches from the operating area attached with the help of a headrest extension device (Bentley et al. 1994) on a standardised chair with controlled frequency and water pressure during treatment procedures. Johnston et al. (1978) have proved that blood agar plates are a valid medium for culturing airborne bacteria. Treatment for all the study patients was carried out by the same dentist on all the days and only one patient was treated per day to allow the room to be free of aerosols. Before each appointment, all dental clinic surfaces were cleaned and disinfected using 80% isopropyl alcohol. Appropriately laundered white coats and drapes were used for each appointment.

Prophylaxis was carried out with a Magnetostriective scaler working at a speed of 30 kHz, with a water pressure of 0.3 MPa during each treatment. A high speed air turbine handpiece, working at a speed of 40000 rpm and with an air drive pressure of 0.25 MPa was used for preparing cavities on carious teeth. First and fourth quadrants were taken as control quadrants and second and third quadrants as experimental quadrants. (Fine et al. 1993a) for oral prophylaxis in all the ten patients. Carious cavities on contralateral sides served as control and experimental quadrants. Treatment was carried out for the control quadrant after the patients rinsed with water, by placing four sterile coded agar plates uncovered at predesignated sites to collect samples of aerosolised bacteria. Following this, patients were asked to rinse with 15 cc of 0.12% chlorhexidine gluconate for 30 seconds and then treatment for the experimental quadrant was carried out by collecting the aerosols in a similar manner to that of the control quadrant.

Microbiological procedure

After the samples were collected they were taken to the Department of Microbiology for further analysis. Five percent human blood agar plates were used in the study, which were incubated at 37°C for 24 hours after collecting the sample. Counting of the colony-forming units was performed by a microbiologist who was blinded regarding the exposure of agar plates to control or experimental quadrants, including time of exposure or location. Alpha haemolytic streptococci producing a green or hazy discoloration with colonies of about 1 mm in diameter on blood agar plates were expressed as colony-forming units per media plate (CFU/plate).

Statistical analysis

A paired sample t-test was performed to compare mean CFU/plate of the two quadrants. The cut-off level for statistical significance was taken at 0.05. Data collected were statistically analysed using SPSS version 11.

Results

Mean colony forming units/agar plate according to treatment and location during oral prophylaxis with an ultrasonic scaler are presented in Table 1. The highest number of colonies was from a patient's chest area, and a maximum of 59.8% reduction was seen after rinsing. The least CFU/plate was seen at a distance of 24 inches away from the operating area. A significantly higher colony count was seen during oral prophylaxis than during cavity preparation.

Table 2 shows mean colony forming units/agar plate according to treatment and location during the use of a high speed dental handpiece. The highest number of colonies was from the patient's chest area, with a mean value of 72.2±13.7, before rinsing with chlorhexidine, and a maximum of 35.4% reduction was seen after rinsing. The least CFU/plate was seen at a distance of 24 inches from the operating area, with a reduction of 18.2% after chlorhexidine rinsing.

Discussion

Almost all dental procedures involving the use of dental handpieces, ultrasonic scalers, air polishing devices and air abrasion units produce aerosols. These range from relatively harmless particles to highly infectious ones. Hence, a safe environment is an important consideration for all dental personnel and patients. Simple and readily available methods can be used to minimise both the number of aerosols and clinicians' exposure to the aerosols in the dental clinic.

In the present study, the efficacy of pre-procedural rinsing with chlorhexidine in reducing bacterial aerosol contamination during dental procedures was assessed. Results showed that a regimen of 30 seconds pre-procedural rinsing with 0.12% chlorhexidine gluconate before the dental procedures significantly reduced colony-forming units than without rinsing due to the ability of antiseptic mouthwash to inhibit microbial growth.

Table 1. Mean colony forming units/agar plate (CFU/plate) according to treatment and locations during use of ultrasonic scaler

<table>
<thead>
<tr>
<th>Location of agar plates</th>
<th>Mean CFU/plate in control quadrant Mean ± SD</th>
<th>Mean CFU/plate in experimental quadrant Mean ± SD</th>
<th>% reduction</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient's chest area</td>
<td>102.4±4.5</td>
<td>60.9±3.6</td>
<td>59.8</td>
<td>0.02</td>
</tr>
<tr>
<td>Operator's chest area</td>
<td>72.4±5.7</td>
<td>31.1±2.5</td>
<td>42.7</td>
<td>0.04</td>
</tr>
<tr>
<td>12 inches from operating area</td>
<td>40.3±2.4</td>
<td>13.2±2.0</td>
<td>32.8</td>
<td>0.05</td>
</tr>
<tr>
<td>24 inches from operating area</td>
<td>25.7±4.1</td>
<td>20.5±2.9</td>
<td>20.2</td>
<td>0.09</td>
</tr>
</tbody>
</table>

p≤0.05 – significant.
Table 2. Mean colony forming units/agar plate (CFU plate) according to treatment and locations during use of high speed dental handpiece

<table>
<thead>
<tr>
<th>Location of agar plates</th>
<th>Mean CFU/plate in control quadrant Mean ± SD</th>
<th>Mean CFU/plate in experimental quadrant Mean ± SD</th>
<th>% reduction</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient's chest area</td>
<td>72.2±3.7</td>
<td>39.9±6.4</td>
<td>55.4</td>
<td>0.03</td>
</tr>
<tr>
<td>Operator's chest area</td>
<td>49.3±6.5</td>
<td>15.6±8.7</td>
<td>31.7</td>
<td>0.04</td>
</tr>
<tr>
<td>12 inches from operating area</td>
<td>53.4±4.5</td>
<td>11.6±2.7</td>
<td>21.8</td>
<td>0.06</td>
</tr>
<tr>
<td>24 inches from operating area</td>
<td>24.6±5.0</td>
<td>20.1±5.7</td>
<td>18.2</td>
<td>0.11</td>
</tr>
</tbody>
</table>

p<0.05 is significant.

Aerosol contamination was more during scaling procedures than during the use of a high speed air turbine handpiece. This increase in microbial contamination can probably be attributed to dental plaque, both supragingival and subgingival, which are the major sources of pathogenic organisms. During both the procedures, the highest number of colonies was seen on the plates positioned on the patient’s chest area, and this is in conformity with a study conducted by Cochran et al (1989) who concluded that the larger salivary droplets generated during dental procedures settle down rapidly from the air with heavy contamination of a patient’s chest area. This was followed by the contamination on the operator’s chest area and 12 inches from the operating area. The least colonies were formed 24 inches away from the operating area, which is also consistent with the study by Logothetis and Martinez-Welles (1995) who a 10-minute waiting period before air polishing was obviously an important factor in the reduction of aerosol contamination.

In a study by Fine et al (1992, 1993b) conducted on 18 participants, a pre-procedural rinsing with 20 ml chlorhexidine mouthwash for 30 seconds produced 94.1% reduction in CFUs compared with the non-rinsed control and the difference was statistically significant (p<0.001). Results from the study by Muir et al (1978) using a similar protocol during ultrasonic scaling showed that a two-minute pre-rinse with chlorhexidine significantly reduced aerosols produced by ultrasonic scalers. Similarly, Vekler et al (1991) using saliva samples, showed that two consecutive 30-second pre-procedural rinsing with chlorhexidine had a profound effect on the bacterial flora of the oral cavity.

Although, as with all infection control procedures, it is impossible to completely eliminate the risk posed by dental aerosols, it is possible to minimise the risk by layering of protective procedures with relatively simple and inexpensive precautions. Hence, along with universal barrier techniques, a routine pre-rinsing with chlorhexidine as an adjunct may have potential in-clinic use as part of an infection control regimen in reducing the extent of contamination, if not in eliminating the infectious potential of dental aerosols generated during the use of dental devices in a dental set up. Continued studies are needed to investigate viable pathogenic organisms including anaerobic bacteria and viruses generated during dental procedures requiring specialised media and with various volumes of pre-rinse or incubation times or a varying time gap between pre-rinsing.

Conflict of Interest statement
None declared.

References

192 Journal of Infection Prevention NOVEMBER 2009 VOL. 10 NO. 6