A pilot study of measurement of the frequency of sounds emitted by high-speed dental air turbines

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(Received 21 February and accepted 5 September 2001)

Abstract: Since the development and use of the high-speed dental air turbine some 45 years ago, concern has been expressed in the literature about a possible cause and effect relationship between use of the drill and hearing loss in dentists. The hearing threshold in humans varies with the frequency of sound. It is well known that dentists experience gradual hearing loss during their working life. The aim of this study was to measure the frequency of sounds emitted by high-speed dental air turbines under different working conditions. Five high-speed dental air turbines were used (2× Trend TC-80 BC W&H Dentalwerk, Austria, 2× Black Pearl Eco Bien-air, Switzerland, 1× Trend TC-80 BC W&H Dentalwerk, Austria. Each turbine was tested under 8 different working conditions: under free working conditions the turbines were tested without burs, with fissure burs, with flare burs, with round burs and with inverted cone burs; under operation they were tested with fissure burs by application to a 3×3×10 mm amalgam block surface, a 3×3×10 mm composite block surface, and the occlusal surface of an extracted molar tooth. Forty sound recordings were made in total using a computer with a microphone (Shure 16 LC) located 30 cm away from the samples, at 10-s intervals using a mixer. Frequency analysis was done by a Cool Edit Pro 1.2 computer program. Data were analyzed by multi-variate analysis with the S.P.S.S 9.05 software program. The average measurement was 6860 Hz. According to the statistical analysis there was no significant difference in the frequencies recorded under different working conditions. There was also no significant difference among the different high-speed dental air turbines at $\alpha = 0.05$, $P > \alpha /2$ levels. These results indicate that under any working conditions, high-speed dental air turbines emit frequencies which can cause hearing loss. (J. Oral Sci. 43, 189-192, 2001)

Key words: hearing loss; frequency; high-speed dental air turbines.

Introduction

Undesirable sounds are produced by high-speed dental air turbines, and questions have been raised in the literature of a possible cause and effect relationship between the use of these drills and hearing loss in dentists (1-3). Within the range of audibility, the sensitivity of the ear varies with frequency. For a young adult with normal hearing, the threshold of audibility at 1000 Hz is 0 dB; at 200 and 15000 Hz it is approximately 20 dB; and at 50 and 18000 Hz it is approximately 50 dB. Frequencies above 20000 Hz are not audible to humans at any intensity (4).

The hearing threshold in humans varies with the frequency of the sound. Exposure for 10-15 years to high
levels of continuous industrial noise seems to raise the threshold to about 4000 Hz and it is also well known that the perception of higher frequencies (over 4000 Hz) is more sensitive to the effect of the aging process than is perception of lower frequencies (5).

Previous studies have noted the existence of complaints of tinnitus and some minimal degree of high frequency sensorineural hearing loss in dentists (3).

Tayler et al. (6), in a controlled study of 45 dentists over a period of several years, reported high-frequency hearing loss in a group of dentists (1,3,6). Weatherton et al. (7) studied dental students and dental faculty members and found that no damage was done to the hearing of the students, but that faculty members showed some minimal hearing loss in the 4000 Hz to 6000 Hz range (7).

Skurr and Bulteau (8) did a controlled study on dental faculty students over a two-year period, and 59% of dental students showed significant hearing loss. It is difficult to imagine that the time between the ages of 21 and 23 years would represent the earliest manifestation of an age change; the age of 35 years is usually regarded as the starting point (8).

Little study has been done about the relationship between hearing loss in dentists and the use of high-speed dental air turbines. The aim of this pilot study was to measure the frequencies emitted by such turbines under different working conditions.

Materials and Methods

Five high-speed dental air turbines were used: 2 × Trend TC-80 BC W&H Dentalwerk, Austria, 2 × Black Pearl Eco Bien-air, Switzerland, 1 × Trend TC-80 BC W&H Dentalwerk, Austria. (Table 1) Each high speed dental air turbine was tested under 8 different working conditions: under free working conditions the turbines were tested without burs, with fissure burs, with flare burs, with round burs, and with inverted cone burs; under operation they were tested with fissure burs by application to a 3 × 3 × 10 mm amalgam block surface, a 3 × 3 × 10 mm composite block surface, and the occlusal surface of an extracted molar tooth. (Table 2) Forty sound recordings were made in total using a computer with a microphone (Shure 16 LC) located 30 cm away from the samples, in 10 second intervals using a mixer. Frequency analysis was done by a Cool Edit Pro 1.2 computer program. Data were analyzed by multivariate analysis with the S.P.S.S 9.05 software program.

Results

Table 3 shows the measured frequencies under different working conditions. The average of the 40 measurements was 6860.2 Hz. Table 4 shows the statistical results. According to the statistical analysis there was no significant difference in the frequencies recorded under different working conditions. There was also no significant difference among the different high-speed dental air turbines at $\alpha = 0.05$, $P > \alpha/2$ levels.

Discussion

In this study statistical analysis showed that there was no significant difference among the groups under any working conditions. The average measurement was 6860 Hz. This indicates that most dentists working in large clinics are at risk of incurring hearing loss.

Education is the only way to decrease the risk of noise-induced hearing loss in dentists and dental personnel working under the same conditions (9). All dentists and dental personnel should be taught the following precepts:

1) Excessive exposure to sounds with frequencies greater than 4000 Hz causes high frequency sensorineural hearing loss (5-9).

2) Hearing damage occurs with good noise (e.g. music) as well as bad noise. If ears are exposed to any loud sound for too long, hearing ability will be permanently damaged (3,9).

3) Persons who work in noisy environments should not engage in noisy hobby activities immediately following a work day. The ear begins to recover its hearing ability when it is allowed to rest. Absolute silence is not necessary for recovery; the ear can also recover its hearing sensitivity in low-noise situations (9).

4) Audiometric testing is currently the best way to detect hearing loss. Regular testing identifies those who have started to lose their hearing, before they acquire significant auditory impairment (9).

In order to minimize the frequency produced by high-speed dental air turbines, production quality and quantitative properties must be developed and improved. It is also important to consider the construction, design and
decoration of the dental clinic. To decrease the frequency, sound absorbent materials (10) similar to those used in television and music studios can be used.

This study, has shown that under any working conditions high-speed dental air turbines emit frequencies high enough to cause hearing loss. Further research about the hearing health of dentists and other dental personnel is required.

**Table 2** Sound recording conditions of the high-speed dental air turbines

<table>
<thead>
<tr>
<th>Number of records and conditions</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free working condition, without burs.</td>
<td>11988</td>
<td>11439</td>
<td>5247</td>
<td>4984</td>
<td>9869</td>
<td></td>
</tr>
<tr>
<td>Free working condition, with round bur.</td>
<td>5575</td>
<td>5795</td>
<td>5205</td>
<td>9855</td>
<td>4797</td>
<td></td>
</tr>
<tr>
<td>Free working condition, with fissure bur.</td>
<td>5523</td>
<td>5853</td>
<td>5131</td>
<td>4741</td>
<td>5374</td>
<td></td>
</tr>
<tr>
<td>Free working condition, with flare bur.</td>
<td>5841</td>
<td>5756</td>
<td>8089</td>
<td>4835</td>
<td>5519</td>
<td></td>
</tr>
<tr>
<td>Free working condition, with inverted cone bur.</td>
<td>5757</td>
<td>5520</td>
<td>8043</td>
<td>4946</td>
<td>5457</td>
<td></td>
</tr>
</tbody>
</table>

**Table 3** Frequency measurement of high-speed dental air turbines under different working conditions (Hz)

<table>
<thead>
<tr>
<th>Number of high-speed dental air turbines</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free working condition, without burs.</td>
<td>8149</td>
<td>5680</td>
<td>10494</td>
<td>9615</td>
<td>8029</td>
<td></td>
</tr>
<tr>
<td>Free working condition, with round bur.</td>
<td>8753</td>
<td>4638</td>
<td>9403</td>
<td>8411</td>
<td>7809</td>
<td></td>
</tr>
<tr>
<td>Free working condition, with fissure bur.</td>
<td>4648</td>
<td>5108</td>
<td>7464</td>
<td>8128</td>
<td>4928</td>
<td></td>
</tr>
<tr>
<td>Free working condition, with flare bur.</td>
<td>5510</td>
<td>6079</td>
<td>7464</td>
<td>8128</td>
<td>4928</td>
<td></td>
</tr>
<tr>
<td>Free working condition, with inverted cone bur.</td>
<td>5757</td>
<td>5520</td>
<td>8043</td>
<td>4946</td>
<td>5457</td>
<td></td>
</tr>
</tbody>
</table>

Note: Measurement results are expressed in Hz.

**Table 4** Results of multi-variate analysis

<table>
<thead>
<tr>
<th>Test of difference between free working groups</th>
<th>According to $P=0.094 &gt; \alpha/2=0.025$</th>
<th>There is no significant difference between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test of difference between fissure bur applied to different mediums</td>
<td>According to $P=0.052 &gt; \alpha/2=0.025$</td>
<td>There is no significant difference between groups</td>
</tr>
<tr>
<td>Test of difference between high-speed dental air turbines in free working groups</td>
<td>According to $P=0.938 &gt; \alpha/2=0.025$</td>
<td>There is no significant difference between groups</td>
</tr>
<tr>
<td>Test of difference between high-speed dental air turbines with fissure bur applied to different mediums</td>
<td>According to $P=0.164 &gt; \alpha/2=0.025$</td>
<td>There is no significant difference between groups</td>
</tr>
</tbody>
</table>

Note: All calculations were done according to Table 3 at $\alpha=0.05$.

**References**
