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WORK-RELATED NOISE HAZARDS IN THE DENTAL SURGERY

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Abstract: The paper discusses sources and characteristics of noise in the dental surgery as well as the mechanism of noise-induced hearing loss. Analysis of the influence of office noise on the hearing of dental doctors has been carried out and the significance of nonoccupational factors noted. Suggestions have been offered on how to reduce noise levels in the surgery.

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INTRODUCTION

Noise is an acoustic phenomenon which mainly arises in a gas, solid or, on occasion, liquid environment. We are all accustomed to everyday "normal noise", which is constantly present all around us. Certain occupations, however, create the kind of noise whose sources are strictly related to the characteristics of the workplace.

Noise is always present during the work of dental staff. It can be roughly divided into distracting noise and destructive noise. This division results from the variety of parameters determining sound hazards and their influence on the human organism.

SOURCES OF OFFICE NOISE

The sources of dental sounds that can be treated as potentially damaging to the hearing are high-speed turbine handpieces, low-speed handpieces, high-velocity suction, ultrasonic instruments and cleaners, vibrators and other mixing devices, and model trimmers. Also worth mentioning are air conditioners and office music played at too loud a volume [11, 17, 21]. Kilpatrick [17] has listed the decibel ratings for various office instruments and equipment, which amount to 70–92 dB for high-speed turbine handpieces, 91 dB for ultrasonic cleaners, 86 dB for ultrasonic scalers, 84 dB for stone mixers and 74 dB for low-speed handpieces.

The energy of the high-speed turbine drill noise lies mainly in the octave bands 4, 6, and 16 kHz. The sound pressure levels are greatest at 6 kHz [19].

In Bahannan's *et al.* [1] study the noise levels of different handpieces and laboratory engines were evaluated. This entailed the use of equipment made by renowned companies such as Kavo (Allgan, Germany), Degussa (Frankfurt, Germany) and Bego (Bremen, Germany), common in numerous dental surgeries worldwide. Handpiece noise measurements were made while instruments were running free and during operation with various cutting tools. The results indicate that there were significant differences among all dental engines measured. The laboratory engines had the highest noise level. The noise levels generated by the laboratory electromotor, the high-speed turbine angled-design, and the low-speed angled-design were decreased, respectively. Thus, the mean level of noise measured in decibels reached for laboratory machines 81.42, for laboratory electromotors 74.95, for angled-design turbine handpieces 72.91 and for low-speed angled-design handpieces 69.71.

The high-speed handpieces make the dentist's work easier and they are pleasant for the patients, yet they generate a higher noise level than low-speed handpieces. This may be attributed to variations in the aerodynamic and structural components of each handpiece. The aerodynamic component is due the turbulence in the air flow path, whereas the structural component is due mostly

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to the bearing of the air turbine rotor. Structural design, such as the bulk and type of material used in the construction of the handpiece, produces differences in the intensity and frequency of noise [14, 22].

The noise levels generated during cutting were significantly higher than those of noncutting, which was proved in the course of the measurements. These demonstrate that the noise level for laboratory machines during cutting is 85.33 dB, without cutting – 77.51, and, respectively, for the laboratory electromotor handpiece - 82.04 and 67.86, the angled-design turbine handpiece - 78.98 and 66.84, the low-speed angled design handpiece 71.89–67.53. This may be attributed to the friction between the cutting material and cutting tools [1].

Technological progress in the construction of drills and other machines used in the dental surgery has led to a lowering of high-frequency noise levels to about 70–85 dB, i.e. to the limit considered as safe [32].

MECHANISM OF NOISE-INDUCED HEARING LOSS

It is commonly known that exposure to noise can induce hearing loss. Noise-induced hearing loss develops slowly over years, is caused by any exposure regularly exceeding a daily average of 90 dB, and proceeds in 3 stages. In the first stage, sensory cells within the cochlea are killed by excessive exposure. The cells do not regenerate; they are replaced by scar tissue. In the second stage, after weeks to years of excessive exposure, hearing loss can be detected audiometrically. Early loss occurs in the high-frequency range, around the highest C note played on a piano. Speech comprehension is not significantly affected; therefore, this loss is seldom noticed unless hearing is tested for some other reason. With continued exposure, the loss spreads to the lower pitches necessary for understanding speech. At this point, the third stage, the patient usually becomes aware of the problem and may seek medical attention [6, 23].

NOISES AND HEARING IN DENTIST

The degree of risk to the individual dentist depends on various factors: personal susceptibility, total daily exposure to the instrument, and patterns of use. As to the intensity of the noise emitted, handpieces differ from manufacturer to manufacturer. Further, as the bearing in the turbine becomes worn, noise increases in a direct ratio [8, 13, 14].

A possible cause and effect relationship between the use of the drill and the loss of hearing in dentists and other functions has been the aim of much research over the years. The present article quotes results of research carried out in the late 1970s and in the 1980s, and published in English-language literature. In selecting the data we were looking for the longest possible period of time in which the dentists under investigation were exposed to the noise of high-speed dental drills, which enabled a better evaluation of how the noise affects the hearing.

Audiological evaluations, consisting of hearing thresholds at eight frequencies (500 to 8000 Hz) and impedance audiometry, were carried out on 70 dentists from eight specialties. No statistical decrease in hearing thresholds appeared in either the speech or high frequencies when the dentists were compared with a normal, age-adjusted population [14].

A pure tone air conduction audiometric evaluation was administered to 137 dentists and 80 physicians. The physicians were found to have better hearing threshold levels, notably in the 4000 Hz center frequency range. The left ear of right handed dentists showed a greater loss of hearing ostensibly related to proximity to the noise source. Dental specialists showed a loss pattern similar to those of general dentists. The findings suggest that there may be a cause and effect relationship between hearing loss and use of the high-speed dental handpiece [33].

Acoustic data from 35 dental surgeries in Nottingham, UK, and subjective histories from 35 dentists were analysed in relation to potential damage risk criteria. They concluded that the present auditory hazard is very slight indeed [9].

234 dentists and dental nurses were examined with a normal and a high-frequency audiometer in high standard clinical conditions. Their ordinary and high-frequency hearing as compared with the controls showed no significant differences. The exposure period in this study, 18 years, can be regarded as long enough to detect possible harmful effects that dental instruments pose for one's hearing, insofar as they have such effects. The authors conclude that modern dental surgical equipment, with high-speed drills, special suctions and ultrasound dental stone extractors, does not appear to be deleterious to ordinary or high-frequency hearing, even with long-term exposure. The authors even suggest that screening procedures to follow the hearing of all dental personnel are not necessary [24].

Pure tone audiograms from 68 dentists with a minimum of 10 years in dental practice were taken in 1973 and follow-up was carried out in 1988. Analysis showed that at the speech range of frequencies dentists did not differ from the reference. At higher frequencies of 4, 6, and 8 kHz dentists tended to have higher hearing thresholds than expected. At 6 Hz, both male and female dentists had highly significantly greater hearing thresholds than expected by the corresponding references in both the studies. This difference remained essentially similar over the follow-up period, indicating that dental drill noise was insufficient to cause continuous loss of hearing [19].

Thus, results of the research do not demonstrate that work-related noise has a significant influence on the hearing of dentists. It must be remembered that the condition of hearing in dental staff, as well as dental related noise, may be affected by smoking, medication or recreational sounds such as rock music, personal stereos and CD players, firearms, etc.

From a review of the literature it is clear that some authors have observed excessive sensory neural hearing

loss due to smoking [25, 29], whereas others did not find such a connection [3, 12]. The work of Starck *et al.* [27] cannot elucidate the exact mechanism by which hearing is deteriorated by tobacco smoking, but it indicates that the hazardous effect of smoking on hearing is mediated in combination with some other factors. Factors such as elevated blood pressure, altered lipid metabolism, peripheral vascular disorders and substances affecting the peripheral blood circulation are believed to aggravate sensory neural hearing loss [16].

The list of ototoxic drugs administered alone or in combination is very extensive. Vancomycin, like erythromycin, is a nonaminoglycoside antibiotic that may produce sensory neural hearing loss. Brummmett *et al.* [5] report that vancomycin-induced ototoxicity is manifested by auditory-nerve damage and hearing loss and is more likely in patients with high plasma concentrations of the drug. Tinnitus and high-tone hearing loss are frequently an antecedent to deafness and must be regarded as an indication to discontinue treatment.

While administering ototoxic drugs it is observed that their discontinuation occasionally improves the hearing, which, however, often continues to deteriorate and the loss may be irreversible [20, 30]. Some factors may increase the likelihood of this adverse reaction: the use of high doses, long periods of treatment, preexisting renal failure, older age, previous episodes of hearing loss, and especially, concomitant intake of other ototoxic drugs [2].

The problem of acoustic risk should be of special concern to younger dentists who, during their childhood and adolescence, may have been exposed to sources of intense noise such as motorcycle and auto racing, target shooting, discotheques, rock concerts, personal stereos and CD players. Faster hearing impairment at a younger age may be expected if in their professional life they are exposed to sound hazards [15].

Participation in rock concerts significantly contributes to a cumulation of noise effects, although the risk of permanent hearing loss resulting from this is reduced to the frequency of attendance. One metaanalysis found that the average sound level at rock concerts was 103.4 dB [7].

An additional source of noise is the widespread use of personal stereos and CD players among the younger generation. Stereos have increased significantly the risk of hearing loss among the users. Some stereos can exceed 120 dB. It is known that the risk of hearing loss by using headphones depends among others on the volume level selected, the time spent listening, the susceptibility of the individual's ear, and the extent of other noisy exposure [7].

Smith and Davis [26] in their debate in *Lancet* quote the results of investigations among people aged 18–25 in Nottingham. Of the 328 people who attend nightclubs, 217 (66%) reported temporary effects afterwards: dullness of hearing, tinnitus, or both. Of those who attend rock concerts, 174 (73%) report these effects. By contrast, only 16 (8%) hi-fi listeners and 30 (17%) personal-stereo listeners report these effects. This finding indicates that young people are quite sensible and the noise is under their control; they do not usually set it so high as to give themselves dulled hearing or tinnitus.

Ownership and use of revolvers, guns, shotguns, high velocity rifles, shooting firearms and automatic weapons constitute nonoccupational noise sources of extreme significance for dental practitioners. These expose their hearing to an impulsive type of noise. Several demographic and laboratory studies prove that impulse noises produce greater amount of hearing loss than continuous noise, and that there are audiological and morphological differences between both types of exposure [28]. Clark *et al.* [6] report that the logarithmic nature of the decibel scale makes it difficult to grasp the amount of acoustic energy in a single gunshot. The energy in a single report from a high-power rifle or shotgun is equivalent to almost 40 hours of continuous exposure at 90 dB.

HEARING SECURITY IN DENTAL SURGERY

The above data do not show that surgery-related noise evidently causes loss of hearing among dental workers. Nevertheless, the staff should try to keep the noise level down to a minimum as a general principle.

The design of the surgery should locate compressors, ultrasonic instrument cleaners and other equipment outside or in an isolated part, whereas the arrangement of the equipment inside the office should not result in an interference of sounds produced by them. Use of several turbines in the working environment should be avoided. Sound-dampening materials ought to be used for finishing the walls and ceilings of offices [31].

Only high quality equipment should be used, with periodic inspections and conservation as recommended by the producer, and, if need be, with repairs using original parts, taking particular care of all rotary and vibratory instruments. Miranda [21] emphasizes especial cognizant of any high-pitched whines that are "different" from when the instrument was initially purchased.

The dentist should maintain a proper distance from the operating field. Kilpatrick [17] recommends the distance from the dentist's eye to the patient's mouth to be 14 inches, i.e. about 35 cm. When the operator is closer, decibel rating increases. Miranda [21] mentions other controllable variables: how the ear is oriented to the working field, the orientation of handpiece exhaust ports to the ears, and the position of the handpiece in relation to the mouth.

The rotary instruments must be activated only when they are ready to be used. According to Forman-Franko *et al.* [14] a reduction occurs by one- to two-thirds when it begins cutting a tooth.

The dentist and the auxiliary staff should work out a procedure of correct manipulation in order to reduce the level of noise. According to Miranda, the use of a rubber dam can reduce the tendency to catch (and possibly injure) soft tissue in the air stream of the suction handpiece [21]. The daily work schedule should be planned so as to allow for pauses in the use of turbines, thus limiting the acoustic trauma to short duration.

If necessary, ear plugs or muffs should be worn since they provide adequate protection. Krammer [18] believes that any system chosen to reduce perception of the surrounding noise has the additional advantage of allowing for better concentration on the work to be done.

The numerous variables influencing acoustic trauma require each dentist to evaluate his own risk by undergoing an otologic examination and an audiometric evaluation. In addition, noise levels in the surgery should be studied, with monitoring periods of at least a week. An audiometric evaluation should be carried out after a typical workday and again at the beginning of the next day, in order to observe temporary threshold shift and apparent recovery. Annual hearing tests should be taken [10]. Besides, it seems that hearing tests taken at the beginning of the professional career (students, young doctors) function as a reference point for the subsequent tests taken during the career, for assessing possible later changes in the ear [4].

CONCLUSION

To sum up, it must be said that the best way to provide comfort and complete security for the hearing of the dentist is to reduce excessive noise in and outside the workplace.

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