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"Hearing Loss which Solutions? Present and Future"

Systematic Review

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Annual Audiometric Evaluation must be Compulsory for Dentists

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ABSTRACT

Aim: This paper aims to present the effect of noise on the auditory functions of dentists, recommendation for an annual hearing test and ways to combat noise at dental clinics on the basis of the findings of existing literature.
Materials and Methods: Various databases like Medline (National Center for Biotechnology information (NCBI), US National Library of Medicine (NLM)), PubMed, Google, Google Scholar were searched for the terms "*Noise and Dentists*", "*Instrumentation in dental places*", "*Hearing thresholds for dentists*", "*Hearing protection devices (HPD) for dentists*" from 1960 till date. The important findings were documented in the narrative manner.
Results: Existing studies and the present review support the idea that dentists are at an increasing risk of developing hearing damage when exposed to high-levels of noise over a long duration. Dentists have been found to report elevated threshold values at high frequencies 4K, 6K indicating noise induced hearing loss (NIHL). Different dental instruments produce different amount of noise. Routine hearing examination and the use of hearing protection devices constitute the compulsory measures for the prevention of hearing loss.
Conclusion: The review and results show that hearing loss due to genetic factors or aging cannot be prevented but hearing loss caused due to noise exposure can be prevented by the use of hearing protection devices in noisy environments. Workers in noisy conditions often have low rates of hearing protection devices utilization. The reasons are many for not using hearing protection devices during noisy dental procedures including discomfort. Annual hearing tests are mandatory to diagnose the effects of noise and provide protection to those affected. The best way to protect themselves from the hazardous effects of noise for dentists is to ensure that they do not remain exposed for long hours to a noisy environment-clinics/laboratory.

KEY WORDS: Noise induced hearing loss (NIHL); Hearing damage; Hearing protection devices (HPD's); Dentists.

ABBREVIATIONS: NIHL: Noise Induced Hearing Loss; HPD's: Hearing Protection Devices; PEL: Permissible Exposure Limit; OSHA: United States Occupational Safety and Health Administration; OAEs: Otoacoustic Emissions.

INTRODUCTION

Dental professionals encounter different occupational hazards on a day to day basis. Hearing loss has been reported to be one of the major hazards in the affected population. Dental practice may be associated with a continued exposure to different noises produced by dental equipments and gadgets used in the patient dental care services. Noise is defined as an acoustic phenomenon which may arise due to a solid, gas or liquid environment.[1] Every individual is exposed to noise in their surroundings which is considered to as "normal noise". Occupational groups such as that of dentists are exposed to an extra amount of noise persistent in their work premises. The common sources of noise in dental offices are attributed to model trimmers, ultrasonic instruments, high velocity suction, low speed hand pieces, vibrators and high speed turbine hand pieces.[1] Dental clinicians may be susceptible to high speed hand pieces which may contribute to hearing loss.[2] The cause and effect relationship between hearing loss and noise exposure is well-documented.[2] Considering the hazardous effects of noise, the United States Occupa-

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tional Safety and Health Administration (OSHA) has laid forth the standards related to noise exposure. In a day, the maximum permissible exposure limit (PEL) has been listed as 8 hours which must not exceed 90 dB SPL (dB SPL using an A weighted scale).[2] Considering the OSHA guidelines allowed for the maximum permissible exposure limit of noise, it has been noted that the noise levels were recorded to be below 85 dB (A) inside the dental clinics. However, with the introduction of cutting activities, the noise levels were recorded as 90 dB (A). According to the permissible hearing loss limits, the level of noise produced in dental clinics were acceptable. But it was an alarming situation for the dental technicians who spend most of the time inside the premises to work without wearing hearing protection devices.[5] Some individuals may be more susceptible towards the noise induced auditory dysfunction and some may not.[2] Many factors which may impact the physiological effects of sound on hearing include exposure length, time duration between successive exposures, susceptibility of exposure, frequency and the intensity of vibration.

MATERIALS AND METHODS

Various databases like Medline (National Center for Biotechnology information (NCBI), US National Library of Medicine (NLM)), PubMed, Google, Google Scholar were searched for the keywords such as "*noise and dentists*", "*instrumentation in dental places*", "*hearing thresholds for dentists*", "*hearing protection devices for dentists*" from 1965 till date. The important findings were documented in narrative manner.

Noise Induced Hearing Loss and its Effects

The injury to the ear can be caused due to loud exposure of sound wave. The important factors determining it are intensity (magnitude) of exposure and frequency.[23] The physiology of sound in hearing stimulation can help us to understand the effects of noise or loud exposure on ear. The brief review of the mechanism can be understood as: the three structures of ear which participate for this mechanism are outer, middle and inner ear. Sound wave travels from outer to middle ear, after its transmission from stapes in coordination with oval window it reaches cochlea, the energy released into the cochlea generates the vibration of liquid in this area.[23] This liquid movement is responsible for the stimulation of the organ of corti and outer hair cells (OHC) and inner hair cell (IHC) of inner ear. High magnitude and high frequencies have been found to be the important parameters for causing effect on sound wave. Magnitude is responsible for increasing of the pressure, and the frequency increases the velocity of the stimulus.[23] High pressure is linked to high magnitude and the quick stimulus through high frequency act on the perilymph stressing the hair cells, in particular the ones in the basal turn. The principle from physics is applicable here as well to understand this mechanism.[23] A quick pressure generates fast movement with small amplitude and runs in shorter distance (basal turn of cochlea). This explains clearly the reason of high frequencies been mostly affected in sensorineural hearing loss while the high pressure is able to increase the pressure in cochlea liquid with sequential hair cells damage due to excessive stress.[23]

Literature Review and Results

A reasonably large number of literary records reporting noise induced hearing loss among dentists continue to exist. The present review also supports that dentists are high risk of hearing loss through the literature review from 1965 to 2017. Higher frequencies beyond 2K has been found to have elevated thresholds in dentists due to noise exposure. Literature findings supports that the use of hearing protection devices can reduce the risk exposed to loud exposure and helps to improve communication. The findings of some of the studies have been summarized below Table.

S. No	Year	Description	Findings
1	1965	Scotland and Taylor et al tested the hearing threshold frequencies of 30 dentists.[3]	The study implemented the use of air turbine drills which could elevate the hearing threshold frequencies at 4k and 6K in dentists. This observation was in accordance with the condition of Noise Induced hearing loss.
2	1980	Zubick et al compared the pure tone threshold of 11 dentists and Physicians (average age 45 years).[4]	Hearing thresholds at 4k, 6k was found to be poorer in dentists as compared to physicians. The study helped establish a link between the use of high speed dental hand piece and consequential hearing loss.
3	1988	Setcos in his study determined the noise levels of different laboratory engines, clinical hand pieces, and other significant instruments like high speed evacuation, ultrasonic scalars etc. The sound levels were measured during different laboratory and clinical practices. The precise measurements were taken with the use of Sound level meters placed at a distance of 2 meters from the operator.[5]	The noise levels were recorded to be below 85 dB (A) inside the dental clinics. However, with the introduction of cutting activities, the noise levels were recorded as 90 dB (A). According to the permissible hearing loss limits, the level of noise produced in dental clinics were acceptable. But it was an alarming situation for the dental technicians who spend most of the time inside the premises to work without wearing hearing protection devices.
4	1959; 1960; 1968; 1998; 1999; 2003;	Several authors documented the usefulness of HPD for dental clinicians.[6-11]	Hearing Protection devices were considered mandatory to ensure protection from noise exposure.

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5	2000	Jolanta Szymanska emphasized on the hearing tests to be performed on dentists[12]	Hearing evaluation should be performed in the beginning of the medical profession in young doctors, students etc. whose threshold could act as a baseline to compare the subsequent changes that take place during their clinical career. This will allow for an opportunity to monitor the changes in auditory functions over the course of time.
6	2005	Khalid investigated the prevalence of hearing problems among dentists in Saudi Arabia.[13]	Among the population screened, 63% had problems in speech discrimination from the background noise, 14.7% experienced difficulty in speech discrimination and 16.6% had tinnitus. The dental professionals who were exposed to noise for more than 4 hours were the most affected group. Through this study the author recommended the use of ear protectors to reduce the effects of field noise.
7	1995; 2006; 2007; 2012.	Fabry, Gijbels et al, Bali et al, Messano & Petti, and Forman Franco et.[14-17]	In their independent studies they concluded that a higher incidence of hearing loss was observed among dental clinicians.
8	2001	Author Morarasu in his study measured the levels of sound in a dental practice with 4 dental units. 1) a Dual Microphone 2) Sound Blaster Live 5.1, and 3)a PC and 4) a special software for data acquisition and analysis.[18]	The premises of dental clinic showed high levels of noise pollution but the sound levels were below the damaging noise frequency for the human ear (85 dB).
9	2006	Sampanio Fernandes in a study measured the noise levels in dental schools which used precision sound level meters placed at a 1 mt distance from the operator with respect to the ear level.[19]	Differences between old and brand new equipments were also observed. The noise levels measured may vary between 60 and 99 dB. It was emphasized that with the use of brand new equipments the risks of causing damage associated with hearing loss was less.
10	2009	Mojarad et al reported that the noise level was recorded in 89 dental offices and 9 dental laboratories[5] using different dental instruments in dental laboratories and dental offices.	1. The greatest amount of noise (49.7 dB) was produced during grinding using the stonecutter (92 dB) and the lowest by the denture polishing unit (41 dB). 2. The maximum sound level recorded in the dental offices was in an audibility range of 85.8 dB and 92 dB in laboratories. 3. The greatest amount of noise was produced using an ultrasonic scaler (85.8 dB). 4. The risks of hearing loss may aggravate if ear protection devices are note used. 5. The maximum noise level recorded in dental offices was below the damaging noise level for the human ears (85 dB).
11.	2014	The study compared the hearing assessment in dental practitioners and other academic professionals from an urban setting.[20]	Results found that the hearing impairment in dentists was slightly higher than in controls. The other important factors such as occupational exposure to high speed hand pieces, environmental noise exposure etc were comparable in both the groups. Occupational exposure to high-speed hand pieces and other noisy devices can cause an extra risk for hearing health deterioration.
12.	2015	The study was performed to measure and compare audiometric pure tone thresholds of dental clinicians, dental professionals and dental students. Also the percentage of these groups who use hearing protection devices while at work in the clinic was determined.[21]	Results showed that dental clinicians who used the high speed hand pieces reported poorer hearing as compared to other study groups. These results emphasized that the prevalence of occupational hearing loss among dental clinicians can be reduced with the use of hearing protective devices.
13.	2016	Myers et al. estimated the risk and prevalence of tinnitus and noise induced hearing loss in dentists. Prevalence of noise induced hearing loss in dentists.[22]	The study through use of sound level measurements and questionnaires indicated that dentists are more prone to hearing health (Sensorineural hearing loss) in their daily work environment.
14.	2017	The study determined the factors responsible for causing noise induced hearing loss (SNHL) in professionals (musicians) supported by temporal bone findings.[23]	The findings supported that the important factors for causing noise induced hearing loss (SNHL) are frequency and magnitude (intensity) of exposure. Time exposed to sound affects the low frequency range. High frequency range between 3K to 6K was mostly found to be mostly affected.

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DISCUSSION

Hearing loss due to genetic factors or aging cannot be prevented but the loss caused due to noise exposure can be prevented by the use of hearing protection devices (HPD's) in noisy environments. Workers in noisy conditions often have low rates of HPD utilization. The reasons are many for not using HPD's during noisy dental procedures including discomfort. The fear in the mind of the noise exposed subjects for not wearing the HPD's are that it might 1) interfere with communication 2) the noise from dental instruments damage hearing and 3) results in a negative feedback from coworkers or patients.[2]

Several recommendations have been made with respect to avoiding noise exposure such as: Noise monitoring should be made mandatory on a routine basis in dental premises and necessary measures should be taken to reduce noise. Noise control can be done at three levels: control at noise source (use of muffles, proper maintained handpiece), control of transmission (resilient floors and sound proof acoustical ceiling) and protection of persons exposed to noise (dental drills should be kept at 35 cm away from ear, simultaneous use of several turbines etc.).[2] Annual hearing tests should be conducted. Annual hearing tests for dentists have also been emphasized upon by the American Dental Association (ADA) council on Dental materials and Devices. Audiologists can take the following steps for dentists to protect them from Noise induced hearing loss (NIHL)[2]:

Step 1: Complete comprehensive baseline evaluation through high frequency audiometry beyond the standard audiometry. Literary findings support the idea that noise induced hearing loss mostly affects high frequencies. Noise induced hearing loss is often associated with a loss of otoacoustic emission.[2] Subclinical noise induced hearing loss can be detected effectively through the use of transient evoked otoacoustic emissions and distortion product otoacoustic emissions (OAEs). Combinatorial research findings have emphasized upon the applicability of DPOAE's and TEOAE's for subclinical NIHL detection. It is recommended that when DPOAE's are involved in testing they should incorporate the testing for five frequencies between 2k and 10K in order to detect any noise notch occurring in this frequency domain.[2]

Step 2: Real time measurements of the noise at workplace must be carried out. Readily available apps for smartphones sound level meters are at times not accurate. Hence, National Office for Occupational Safety (NIOSH) has recently released an easy-to-use, highly accurate sound level meter app for iOS devices. With this application, the patients can take measurements of their workplace noise in real-time and send the results directly to the doctor concerned. Patients can be instructed to place the microphone close to the location of their ear for accurate measurements of noise reaching their ears. This will support the possibility to achieve accurate records to protect the affected from the reaching the risk limits and acquiring the necessary level of attenuation for hearing protection. The environment in which the sound is recorded plays an important role for the efficacy of the application used.

Step 3: Each client (dentist) can have a different noise environment and a different need of noise protection. Audiologists must develop a plan for noise protection in close understanding with the needs of the patient. Using the noise measurements taken in the workplace, a certain level of attenuation is selected that helps control harmful noise levels while keeping conversations with staff members and patients audible. Finally, patients among the dentists are encouraged to maintain and replace their dental equipments as recommended by the manufacturer on time which can further lead to positive results in terms of noise attenuation.

Step 4: An annual monitoring protocol must be established. According to the ADA it is mandatory to conduct annual hearing tests for all dentists regularly exposed to occupational noise. These clinical follow-ups should include an updated case history and medical intake information, updated conventional audiometric thresholds, high-frequency audiometry, and otoacoustic emissions (OAEs). Regular monitoring of the clinically significant changes is performed and accordingly the choice of noise protectors is made.

CONCLUSION

Thus to overcome the hazardous effects of noise to prevent hearing risks is to avoid long stretched hours of exposure in noisy premises (clinics/laboratory) for the dentists. Hearing protection devices must be worn compulsorily whenever exposed to loud noise. The selection of the appropriate hearing protection devices at the workplace must take into consideration important factors such as each person's individual susceptibility to hearing loss to noise induced hearing loss, gender and age of participants, duration and the type of hand piece.

CONFLICTS OF INTEREST

The author declares that there is no conflicts of interest.

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