PACIFIC JOURNAL OF MEDICAL SCIENCES

{Formerly: Medical Sciences Bulletin}

ISSN: 2072 – 1625

Pac. J. Med. Sci. (PJMS)

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ABSTRACT:
Dental professionals are subjected to noise from dental equipment and instruments throughout the day at work. Although most of the individual instruments have sound emission below the safety level stated by Occupation safety and health administration (OSHA), running of multiple instruments in close proximity for long hours and over several years causes hearing loss in dental professionals. Changes such as irritability, constriction of blood vessels, increase in heart rate and blood pressure, tinnitus and decreased hearing sensitivity is associated with exposure to high levels of noise. Cumulative effect of excess noise can lead to damage to the cochlea causing irreversible damage to hearing. Dentists begin to show reduction in hearing to high frequency sound at 4000 to 6000 Hz but remain unaware of the problem till 28% of hearing loss has occurred. Dental professionals working in a dental school set-up are at an increased risk for noise induced hearing loss due to the proximity to pre-clinical, clinical and laboratory equipment during their work day. Dental students and professionals should be educated about these hazards and advised to use preventive measures to reduce disability. Employees should be informed of the potential for hearing loss and protocols should be in place to make such working environments safer.

Keywords: Occupational hazard, Hearing loss, Tinnitus
Submitted August, Accepted October 2017

INTRODUCTION:

Sound is a stimulus caused by vibration and detected by the sense of hearing. Noise is an acoustic phenomenon that can occur in gas, solid or at times in liquid. Sound is measured in decibel (dB) for its intensity or by a frequency range (Hertz, Hz) [1]. Sound is audible at the frequency of 20 Hz to 20 KHz [2]. While we are accustomed to the “normal noise” that is present around us, certain professionals are subjected to additional noises in their work environment. Such excess noise can be a potential occupational hazard and care should be taken to minimise disability caused due to such situations.

Noise induced hearing loss (NIHL) is stated as one of the 10 leading causes of work related

injuries [3]. The extent of damage to hearing depends on a variety of factors such as the type and intensity of sound, total duration of exposure, duration of individual exposures throughout the day, distance from the source and the age and susceptibility of the individual [3]. Since decibel is a logarithmic unit, an increase by three decibels results in doubling of the sound intensity. While 10 dB of sound is 10 times greater than zero dB, 20 dB is100 times greater than zero dB [1]. This is important while monitoring sound in an environment as well as during efforts of prevention of NIHL.

Properties of noise:

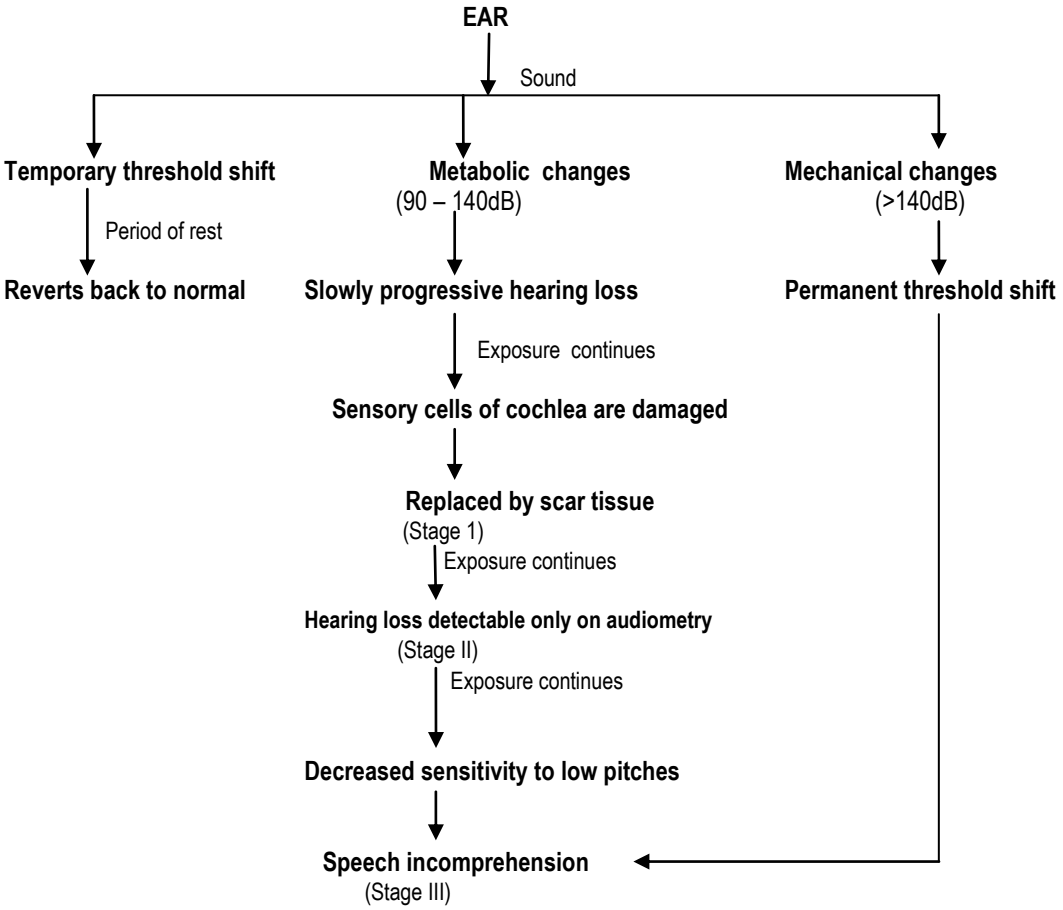
Intensity, duration and spectrum are the three properties of noise that, along with time characteristics and physical make-up determine the risk to hearing [4]. Greater damage to hearing is seen at higher intensity of sound. But this damage is dependent on the temporal patterns of exposure. If the sound is continuous without variations, it is defined as a steady state and if it varies over time, it is defined as fluctuating. Intermittent noise is a combination of hazardous level of noise for certain periods of time with a non-hazardous level of noise. Impulse noise is present only for a short amount of time [5]. According to Feuerstein the greater the duration of exposure to noise, the greater is the damage to hearing. Most of the exposures to noise occur in the complex, variable broadband of signals in the spectrum of sound [4].

Mechanism of loss of hearing:

Changes in the length of the outer cochlear hair induce energy within the cochlea which corresponds to sensitivity to sound intensity and the ability to distinguish between small changes in sound frequency. Damage to this delicate mechanism causes a loss in hearing ability. NIHL maybe temporary or permanent (Figure 1); Temporary loss of hearing is reversible after a period of rest [3]. This is known as temporary threshold shift [4]. Exposure to high intensity noise in the excess of 140 dB even for a short duration causes immediate and permanent loss of hearing known as permanent threshold shift [3, 4]. Here, the delicate tissues of the inner ear are stretched beyond their elastic limits causing a tear. This type of mechanical damage is termed ‘acoustic trauma’ and develops rapidly. Exposure to intensity of sound between 90 and 140 dB induces metabolic changes in the cochlea and causes loss of hearing depending on the duration and level of exposure [3]. This type of hearing loss is slowly progressive over the course of several years and follows three stages. In the first stage, the sensory cells within the cochlea are damaged due to constant exposure to noise. They are later replaced by scar tissue since they do not regenerate. As the exposure continues over a period of weeks or years, the loss in hearing becomes detectable through audiometry. Hearing loss that is detected only through audiometric tests constitutes the second stage of hearing loss [1]. Pure tone audiometry is the first test that quantitatively detects hearing loss and

can be used to assess the nature and degree of damage in adults and children over the age of four years. Otoacoustic emission can also be tested to detect early changes in the inner ear [3]. Use of these tests to detect deficiencies of hearing can help to plan an early intervention and prevent progression of hearing loss. If appropriate testing is not instituted at this stage, it remains undetected by the individual since speech comprehension is not significantly affected [1]. It progresses to the third stage of hearing loss where the patient becomes aware of the loss in sensitivity to sound of lower pitches necessary to understand speech and thus seeks medical attention.[2] Unfortunately, the loss of hearing is permanent at this stage and cannot be improved even with medical intervention.[1] This underlines the importance of monitoring the ambient noise in the environment and taking appropriate steps to prevent loss of hearing before permanent disability has occurred.

Figure 1: Flowchart showing the mechanism of noise induce hearing loss at different sound levels



Effect of noise:

Effect of noise on persons subjected to it can be categorised as non-auditory and auditory. Non-auditory effects include annoyance, irritability, emotional frustration, inability to concentrate, mental fatigue, reduction in work efficiency and productivity, interference with communication and difficulty in speech discrimination.[1,3,6] Auditory effects that are seen include tinnitus, auditory fatigue(90 dB or 400 Hz), temporary deafness (4000-6000 Hz) and permanent deafness (100 dB).[3] Physical effects such as constriction of blood vessels and increase in pulse rate and blood pressure are also seen.[6] Fernandes et al [2] found that noise in a dental classroom environment caused annoyance and negatively affected the metal performance including concentration and visual perception in persons sensitive to low frequency noise in the range of 10-250 Hz. Persons with loss in hearing are also plagued by other problems such as social isolation, inability to effectively communicate with family, co-workers or the public, decreased ability to detect equipment sounds or warning signals in the work environment leading to decreased productivity and increased risk of accidents and increased expenses for procuring hearing aids.[7]

Source of noise in dental office:

Since the advent of ultra-speed air turbine in the 1957 dentists have been concerned about the rise in environmental noise level in the dental operatory. Subsequently a warning was issued in 1959 regarding high turbine machine noises and vibrations.[8] Various equipment and instruments used in the dental office such as electric generators, low speed and high speed angle-design and straight design hand-pieces, autoclaves, laboratory electromotor, compressors, ultrasonic scalers and cleaners, stone mixers, polishers and lathe are sources of significant noise [9]. Myers et al [10] found that low speed hand-pieces produced an average sound pressure of 70.41 dBA (decibel measured using A-weighted scale) while high speed hand-pieces produced a maximum of 83.59 dBA. When suction was used along with the hand-pieces the sound levels increased to 94.77 dBA.[10] According to a study conducted in 1993, slow speed hand-pieces produced sound of 69.71 dB, turbine produced 72.91 dB of sound, laboratory electromotor produced 74.95 dB sound and the highest sound produced was by laboratory machines in the range of 81.42 dB. [11] Klipatrick found that slow speed hand-pieces produced 74 dB, high speed hand-pieces 70-92 dB, stone mixers 84 dB and ultrasonic scalers 86 dB of noise.[12] Fernandes et al [2] in Portugal (60-99 dB) and Kadanakuppeet al [13] in India (64-97 dB) found similar levels of sound in dental school setting.

Risk to dental professionals:

Occupational NIHL is defined as progressive bilateral sensorineural hearing loss that develops gradually over a period of several years because of exposure to continuous or intermittent loud

noise in the work place.[14] In an attempt to decrease the disability caused due to occupational noise exposure, Occupational Safety and Health Administration (OSHA) and National Institute of Occupational Safety and Health (NIOSH) put forward guidelines stating that the maximum permissible exposure limit (PEL) for an eight hour work day was 90 dBA SPL(decibel sound pressure level measured using A-weighted scale). This PEL follows an exchange rate of 5 dB. Therefore, an exposure of 95 dB reduces the permissible working hours to four hours, 100 dB to two hours and so on.[15] Although this PEL is formulated keeping the large scale population in mind, individual susceptibility within this general population can vary greatly.[15] Therefore, care should be taken to avoid exposure to undue noise or to use hearing protection devices (HPD) if avoidance of noise is not possible. Various studies that were conducted to assess the hearing of dentists have been unequivocal in their inference that dentists who have been regularly exposed to noises from dental equipment have reduced hearing while compared with age matched controls. Authors have found that dentists showed abnormal auditory threshold at 4000 and 6000 Hz which is characteristic of NIHL [16,17]. Lazar et al [18] found that dental hygienists who had higher use of ultrasonic scalers reported of difficulty in hearing and tested poorer in pure tone audiometry up to two times more than hygienists who used scalers less frequently. Myers et al[10] found that although none of the instruments used in a dental clinical set up produced sound in excess of the OSHA and NIOSH guidelines and the sound level in dental training operatory was also below the established cut-off level, this could not be compared with a clinical set up where suction would also be used simultaneously thereby increasing the over-all sound level of the environment. Their study subjects reported to the presence of tinnitus and claimed that it got worse at the end of the day [10]. Theodoroff et al [15] found that dental professionals and clinicians who had been practicing dentistry over a period of few years had worse hearing than dental students who were relatively new to the exposure of sound from dental instruments. It was seen that when sound was measured near the operator's ear that was closest to the instrument, the level was sufficiently high enough to cause hearing damage especially with cumulative effect over time.[15]

Bowman et al [19] found that dental students experienced a temporary threshold shift in their hearing after working in the dental laboratories. Singh et al [20] assessed sound levels in a dental teaching institute and found that sound levels were always higher in the laboratories when compared to the levels in clinical set-up even with the suction pump running. They compared the running of multiple air rotors, multiple micromotors and multiple ultrasonic scalers and found that scalers caused higher sound levels than the other instruments [20]. Fernandes et al [2] also found that sound levels in the gypsum and prosthesis laboratory were higher than in

pre-clinical or clinical set-up and that noise was higher for cutting instruments than non-cutting instruments. Parkaret al [6] also found similar results and additionally showed that gypsum lathe trimmers were the noisiest dental instruments and that suction pumps produced more noise when in contact with mucosa than when not in contact. Willershausen et al [8] found that when dentists were compared with other academicians, the former group had higher incidence of impaired air conduction but not bone conduction.

Zubicket al [17] stated that there was a cause and effect relationship between the use of high speed hand-piece and hearing loss since they found in their study that dentists had worse hearing threshold than physicians at the 4000 Hz frequency range and that the right ear of the dentists fared worse than the left due to its closer proximity to working instruments. Right handed dentists show an increased loss of hearing in the left ear and dentists working in a dental school show increased prevalence of hearing defect due to being subjected to the noise of several instruments working at the same time in a medium sized closed room [21]. Although some researches did not find any difference between the hearing ability of dentists and non-dentists or associated the loss of hearing to presbycusis rather than to the noise in dental office, it is still advisable to protect one's ears with HPD when exposed to such potentially harmful noises.[22,23] However, it is seen that dental professionals forgo the use of HPD due to a variety of reasons. While some individuals are unaware or underestimate the danger, others state that they do not use HPD due to discomfort, inconvenience, fear of negative feedback from co-workers and patients or fear of difficulty in communicating with patients [3,15].

Prevention of noise induced hearing loss:

Hearing loss remains undetected until 28% of the damage has occurred.[21] The defect is cumulative, irreversible and potentially detrimental in social and professional situations alike. Dentists show high frequency hearing loss at 4000-6000 Hz in the beginning that slowly progresses depending on the amount and duration of exposure.[20,21]Unlike industrial workers who work in a noisy environment, dental and medical professionals are not bound by any legislature regarding occupational noise levels.[24] Kilpatrick suggested that the distance between a dentist's eye and the working surface should be at least 14 inches or 35 centimetres to prevent excess noise from damaging the operator.[12] An appropriate hearing conservation program that includes noise survey with noise dosimeter and periodic audiometric check-ups, administrative control, engineering control and use of HPD is essential in a dental office.[1,3,21]

Engineering control of acoustics in a clinic should be designed to include wood panels, sound-proof resilient ceilings, carpeting of floors and air conditioners to filter or absorb noise from all sources.[1,21] Compressors and generators

should be stationed outside the operatory. Ambient noise such as office music should be kept to a minimum.[1] Instruments are found to produce higher noise levels as they age and go through more sterilization cycles.[2,18] Hand-pieces should be well maintained and lubricated and old instruments should be replaced with new instruments to decrease the noise produced due to frictional wear.[1,3,20] Simultaneous use of several instruments should be avoided and instruments should be switched on only when required.[1] Contact of suction pumps with the mucosa should be avoided whenever possible.[21]Instruments with added mufflers should be designed to reduce the amount of sound emission [1]. Employees should be informed of the potential for hearing loss and audiometric test should be done at the time of employment and every six years thereafter.[6] Appointment times should be scheduled such that a minimum number of personnel are working with high noise producing instruments at a time. Rotation of employees should be done so that every operator gets placed in a low noise environment to heal the temporary threshold shift. Generic ear plugs made of foam or flanged plastic or custom-made ear plugs called 'musician's ear plug' should be used to protect residual hearing.[20,21] Semi-insert ear plugs in particular can be used since they do not hamper communication between the dentist and the patient and enable the dentist to be aware of surrounding sounds while at the same time being protected from damaging levels of noise.[10] Patients should also be educated about the potential harm to their hearing, however minimal, and offered the use of ear plugs. Patients with hearing aids should be instructed to remove the devices before treatment [21].

CONCLUSION:

It is often seen that dental professionals underestimate their exposure to damaging levels of noise in their work environment. Cumulative effect of acoustic trauma should be taken into account and appropriate measures should be instituted to prevent disability. Employers should ensure that the work place is appropriately planned and that all employees are aware of the associated risks and are provided with adequate measures to protect themselves before irreversible damage is done. Dental curriculum should include education about various occupational hazards and continuing education programs should be directed at methods to reduce noise and protect the hearing of dental professionals.

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