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The effect of the high speed handpiece and other items of equipment on hearing is a debatable issue. There is, however, a need for concern in the Military environment and other large clinical settings.

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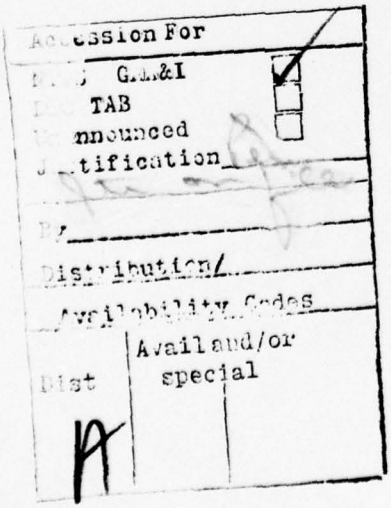
NOISE HAZARDS
IN THE
PRACTICE OF DENTISTRY

by

Walter D. Shields, DDS
Major, Dental Corps, United States Army
Resident, Periodontics
United States Army Institute of Dental Research
Washington, DC 20012



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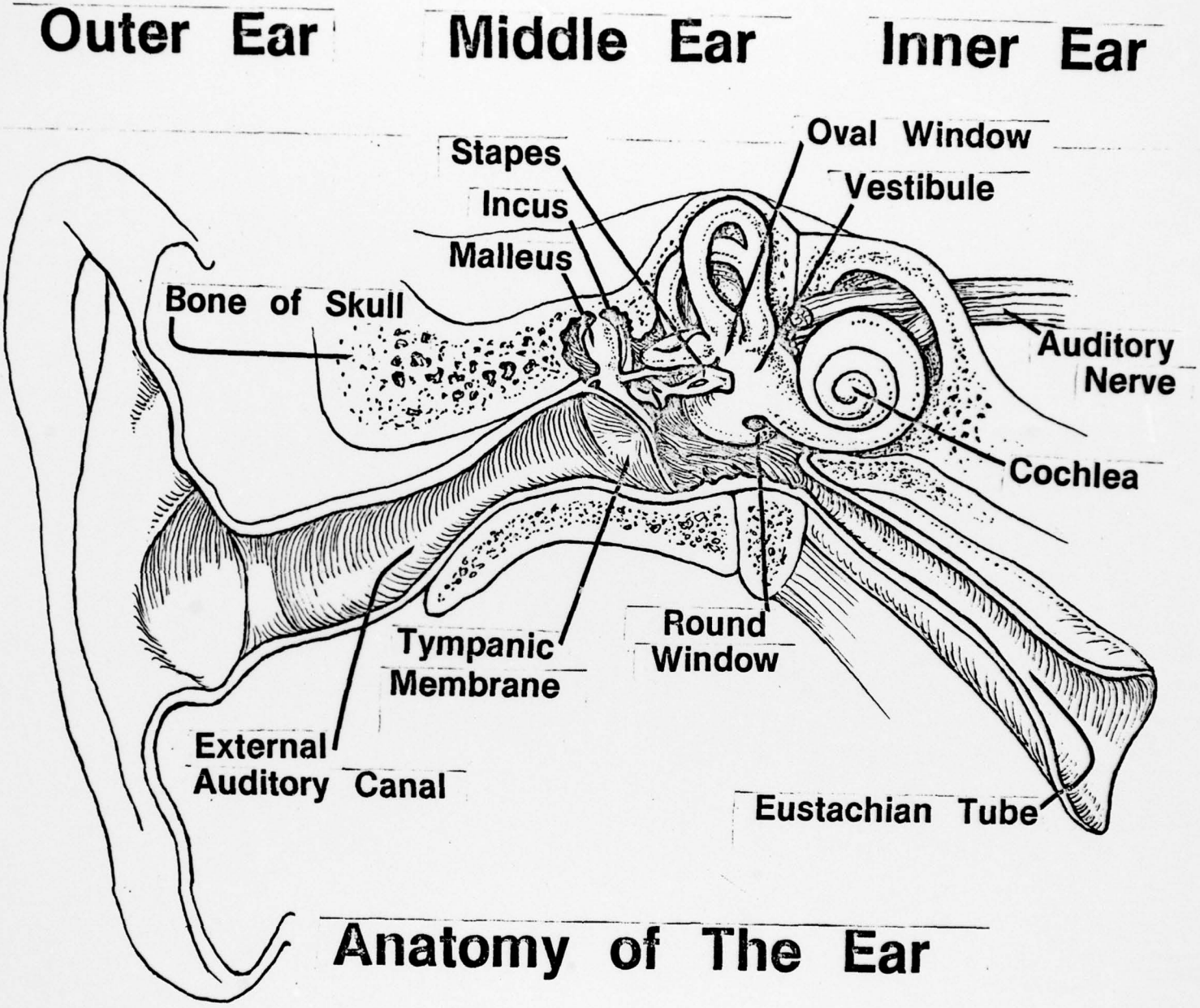

Outer Ear
Middle Ear
Inner Ear
Stapes
Incus
Malleus
Oval Window
Vestibule
Bone of Skull
Auditory Nerve
Cochlea
Tympanic Membrane
Round Window
External Auditory Canal
Eustachian Tube
Anatomy of The Ear

NOISE HAZARDS IN THE PRACTICE OF DENTISTRY

-Introduction-

With the advent of the high speed handpiece in 1957[1] came a revolution in efficiency for dentistry, but there appeared to be concern over the potential harmful effects to the ear from high frequency noise exposure. The studies that have arisen both support and deny that there is evidence of hearing loss. It is the purpose of this paper to present a rationale in support of the danger of this environmental hazard and to propose a practical prevention program.

Fig 1

-The Mechanics of Hearing-

The ability to hear is directly proportional to the ability to transmit sound from the external environment to the brain.[2] The phenomenon of hearing is dependent on the functional anatomy which is composed of three regions: the outer, inner, and middle ear. When sound is conducted in the external environment, it sets the air in motion like ripples after a pebble is thrown into a pond. These ripples of air travel into the external ear region, up to the tympannic membrane, the eardrum. The air vibrations set the eardrum in motion and this sets the components of the middle ear in motion. Here, the small ossicles, the incus, malleus, and stapes, pick up the vibration of the eardrum and transfer the energy of motion to the oval window which is the membrane that covers the entrance to the inner ear. Up to this point, sound has been converted from air energy to mechanical motion in the middle ear.

Once the oval window is vibrated, this activates the components of the inner ear which is a closed system that is filled with a fluid called perilymph. The region of the inner ear called the cochlea contains tiny hairs that are connected at their bases to the auditory nerve. When the perilymph is set in motion, these small hairs vibrate accordingly. This action stimulates the auditory nerve to send an impulse to the brain resulting in the phenomenon of hearing. Any disruption in this normal anatomy will affect the efficiency of hearing.

Sound is quantified in terms of intensity and frequency. Using the analogy of the ripples in a pond, frequency is the number of ripples per

unit of time that occur, while intensity is the height of the ripples that are generated. In other terms, frequency which is measured in Herz is known as pitch. Intensity which is measured in decibels refers to the loudness of sound. The average range of frequency that the human ear discerns is approximately from 64 to 8,192 Hz. at a loudness of 20 db.[2] Hearing is evaluated in this frequency range by finding out at what decibel level in each frequency that sound is heard. The higher the decibel reading means that it takes a louder sound to activate the hearing mechanism and this may be interpreted as an impairment in the auditory apparatus.

There are numerous conditions that may be pathological to the hearing mechanism, but the one with which this paper is concerned is high intensity sound in the high frequency range during the use of the high speed handpiece in dental procedures. It results in a scrambling of the hair cells in the cochlea in turn reducing the ability to pick up sound stimulation.

-Reasons for Concern-

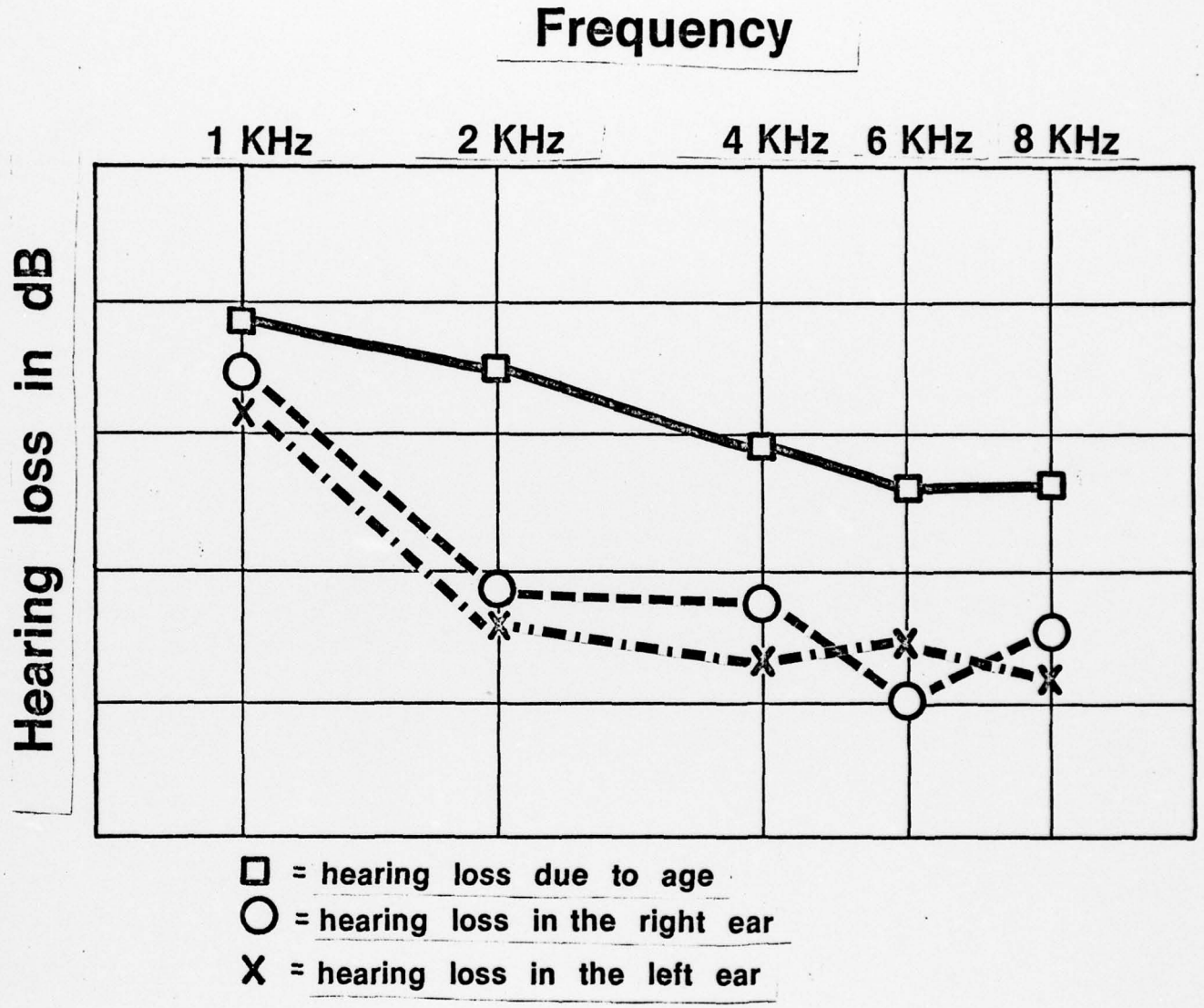
Whether or not the dentist should be concerned about the danger to hearing depends on several variable parameters occuring in the working environment. The handpiece which appears to be the noise hazard of primary concern may operate over a range of frequencies depending on the state of repair, degree of wear, and bur (drill bit) concentricity.[3] These frequencies may offer a blend of noises which will include frequencies at or above the normal range of hearing. Hearing loss is detected first in the ranges above normal, but over a length of time these blends of frequencies

will encroach into the perceptive range of hearing. Whether or not a frequency is damaging depends on its loudness or decibel level. The decibel level will be affected by the same factors influencing frequency.

Looking at the standards set by the Williams-Steiger Occupational Safety and Health Act (OSHA), the American Congress of Industrial Hygienists, and the United States Air Force, another parameter appears: the length of exposure will determine whether or not a sound at a particular frequency and loudness will present a hazard.

Duration Per Day (Hours)	dBA OSHA	dBA ACGIH	dBA USAF
16	-	80	80
8	90	85	84
6	92	-	86
4	95	90	88
3	97	-	-
2	100	95	92
1.5	102	-	-
1	105	100	96
.5	110	105	100
.25	115	110	104
.125	-	115	108

The length of exposure to the sound from the handpiece will vary according to the type of practice, but a study conducted by the Air Force stated that the average exposure time amounted to 14.5 minutes a day.[5] Combining this data with the fact that a typical air bearing handpiece operates in the 60 to 88 db. range and the ballbearing handpiece operates in the 75 to 94 db. range, it is conceivable that there are no dangers to hearing according to the above


Frequency
1 KHz
2 KHz
4 KHz
6 KHz
8 KHz
Hearing loss in dB
□ = hearing loss due to age
○ = hearing loss in the right ear
X = hearing loss in the left ear

standards with the exception that with an increase in age, people tend to have a reduction in auditory efficiency.

Considering the typical multiple chair military dental clinic, handpieces are being operated by different individual dentists throughout a work day. This observation begins to place some serious doubts on the validity of the study conducted by the Air Force.

Is there reason for concern among dentists for the danger of exposure to the sound from high speed dental handpieces? In 1970, a study conducted on Australian dental students found that five out of nineteen individuals who demonstrated hearing deficits had been exposed only to high speed handpiece noise and had had normal hearing at the onset of the study which had spanned two years.[6]

Fig 2.

Age has been shown to have a detrimental effect on hearing and it has been used by some as an etiological scapegoat. When the effects of aging are superimposed on the effects from high speed dental noise, the latter has a greater effect on hearing.[7] This particular study was comparing dental students with faculty who had an average of fifteen years practice. An inference that can be derived here is that the length of exposure is directly proportional to the amount of hearing loss.

-The Fort Hood Study-

In 1974 at Fort Hood, Texas, baseline audiograms were administered to forty-four dental officers participating in a hearing conservation program. Ambient noise levels existing throughout the clinics were measured as well as the dental equipment being used. The results of the audiograms showed that thirty per cent had some degree of hearing impairment. Twenty-three per cent of the men who showed some degree of hearing loss had moderate to severe high frequency range damage. "All of the losses noted were in the higher frequency ranges and can be assumed from previous research that they are typical of a noise induced loss and were probably preventable."[8] The equipment in the clinics and laboratories produced the following noise levels:

CLINIC EQUIPMENT	handpiece	76 - 105 db.
	suction	74 - 80 db.
LABORATORY EQUIPMENT	vibrator	78 db.
	grinder	82 - 96 db.
	lathe	84 - 86 db.

The personnel who work in the various clinics are exposed to these noise levels from four to six hours daily. The noise levels noted in each of the clinics clearly exceed the criteria for noise exposure according to U. S. Army standards (TB Med 251).[8]

Although hearing studies almost exclusively have been directed at the dentist, danger exists for all personnel in the dental clinic. Hearing loss is progressive and painless. Dental personnel are constantly exposed to the high frequency range of noise level and by the time that effects are noticed in the normal ranges of hearing, there has been considerable irreversible damage. The ear is capable of recovering from hazardous sound if the duration of exposure is short and there is an adequate rest period. Without these conditions, a temporary hearing deficit progresses to a permanent loss.[3]

-Prevention-

A prevention program for this problem starts with an examination from a physician and a baseline audiogram. Any undetected abnormalities will be detected and a tailored prevention program can be recommended at this time.

There are a variety of protective devices for the ear today but because of several misconceptions, they are not always worn. Discomfort may arise in a few individuals who use earplug devices. This may mean that their ears may not accommodate plugs well and they may need to utilize earmuffs. Anyone contemplating using protection for their hearing naturally is worried that their ability to hear their fellow workers and to communicate will be affected. The purpose of these devices is to reduce the decibel level of the environment to a physiologically tolerable level. This means that normal conversation should not be affected. Again with a thorough ear examination, all questions can be answered while providing a hearing conservation program tailored to the individual.

A good seal is necessary before any protective device can be maximally effective. A sure sign that this is present is that user should experience a perceptual change in the sound of his or her voice, i.e., it will sound muffled or lower as if the individual was talking inside a barrel. Since the sound coming through the ear canal is attenuated, the sound conducted through the skull bones is more noticeable and it is of a deeper pitch than the sound of normal speech.[9]

Due to simplicity, ease of use, and comfort, the earmuff and the hand foam earplug will be discussed. Because of appearance, the plug is preferred over the earmuffs; however, conditions existing in the ear, e.g. chronic infections, can be aggrevated and then earmuffs are preferred.[9]

In order to be effective, the foam earplug must be inserted properly into the ear canal. After rolling it into a cylindrical mass with the thumb and forefinger, grasp the ear with the opposite hand by reaching over the head and pulling the ear outward. Insert the plug quickly into the canal and hold it gently in place for about one minute until expansion is complete. Once inserted, the foam plug will provide a contoured seal that is both comfortable and effective. After each use they should be cleaned with soap and warm water to avoid contamination of the ear canal.[9] The major advantage of earplugs is their compatibility with glasses, earrings, and other types of head gear. While they are economical and easily stored, they may not be used in an unhealthy ear, will require periodic reseating, and require some expertise in their insertion. In comparison to earmuffs, earplugs provide more variance in attenuation levels.

When earmuffs must be used, the headband should be adjusted to insure the earcup seals are in complete contact with the head. These, as well as the earplugs, should produce a deeper perceived sound of the individual's voice. The wearing of eyeglasses may be a source for reducing the effectiveness of the earmuffs, so special attention to seal should be given in this circumstance. Any earcups that have become hardened, damaged, or unserviceable should be replaced. While earmuffs are bulky and expensive, they require minimal expertise in their use, will fit almost any head with one size, and can be worn in the presence of infection.[9]

Both earplugs and earmuffs may be obtained through the federal supply system. The hand formed plug is yellow and comes in lots of 400, costing $17.10 per box. The national stock number (NSN) is NSN 6516-00-137-6345. Earmuffs are available that can be worn with the suspension system either over the head, behind the head, or under the chin. This feature will help to lessen the problem caused with glasses. The national stock number is NSN 4240-00-022-2946.[9]

Other measures that may be considered include providing better acoustic absorption in the clinic and relocation of equipment that may add to the effect of the high speed handpiece. These measures may be costly and impossible in some clinics. The earplugs and earmuffs offer simplicity, economy, and instant utilization.

-Conclusion-

Although there are several conflicting reports, there appears to be more than enough reason to be concerned about the hazards to hearing in

dentistry. Once this damage is to a noticeable level, there has been considerable irreversible damage. It behooves the practitioner to institute a hearing conservation program for himself and his fellow workers. Keeping this program simple and easy to use will help insure acceptance and, in turn, to provide adequate protection for everyone concerned.

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*This paper does not reflect the opinion of the United States Army Dental Corps and is the view of the author.

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