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Harold F. Schuknecht

Hendrik Van Den Ende

ACOUSTIC TRAUMA FROM A DOG TRAINING WHISTLE

HAROLD F. SCHUKNECHT, M.D.*
and
HENDRIK VAN DEN ENDE, E.E. (Delft)*

It is well-known that the inner ear may be injured from exposure to high intensity sound. This may result from a single shock pulse (such as a blast) or from prolonged exposure to high intensity sound (such as factory noise). It has recently been shown that a similar inner ear injury can result from a bone conducted shock pulse (sound wave) produced by a blow to the head.

The mechanism of injury is violent displacement of the basilar membrane resulting in disruption of the organ of Corti. The cells of the sense organ do not regenerate so that destruction of them results in permanent hearing loss.

Broad spectrum high intensity sounds usually produce the greatest injury in the basal turn of the cochlea in the area which serves the 4000 to 8000 cps frequencies. When the sound is sharply limited in its spectral characteristics, the inner ear usually is injured most severely in the area of the cochlea which responds to that frequency range.

The first symptom noted by patients exposed repeatedly to high intensity occupational noise is diminished hearing at the end of the work day with recovery after several hours. This condition is known as "auditory fatigue". Another symptom often distressing to the patient is "ringing" in the ears (tinnitus). These early symptoms should serve as a warning to individuals working in noise.

Further inner ear injury can be avoided by the use of protective ear plugs. Thus, when an individual experiences these early symptoms tests of hearing should be made and, when indicated, measurements should be made of the spectral characterictics and intensity of the sound environment so that appropriate protective measures can be instituted.

An unusual case which came to our attention recently was that of a trainer of hunting dogs who noticed a progressive hearing loss. He constantly used a whistle which was audible to the human ear. We analyzed the spectral and intensity dimensions of the whistle noise to establish more clearly the relationship of the hearing loss to his occupation.

The patient had been training hunting dogs for about five years and noticed for several months that at the end of a long day of work his hearing was diminshed and that recovery occurred after several hours rest. He preferred to use the louder of two whistles in his possession because the dogs were more responsive to it. He was aware of the probable relationship between the whistle and the hearing loss, and had worn protective ear plugs intermittently. He did not persist in their use, however, because while wearing them he felt somewhat handicapped in the execution of his work. He also used a gun during some of the training sessions, discharging it repeatedly during these periods. Characteristically, hearing losses resulting from shotgun fire

*Otological Research Laboratory.

result in a greater loss in one ear than the other, this being due to the position of the head in relation to the muzzle blast. Thus, for an individual shooting from the right shoulder, the loss is always greater in the left ear.

For our patient, the audiometric thresholds for the two ears were symmetrical. Therefore, we believe that his hearing loss is due to the whistle which exposes both ears symmetrically and not to the shotgun blasts which would expose the ears asymmetrically.

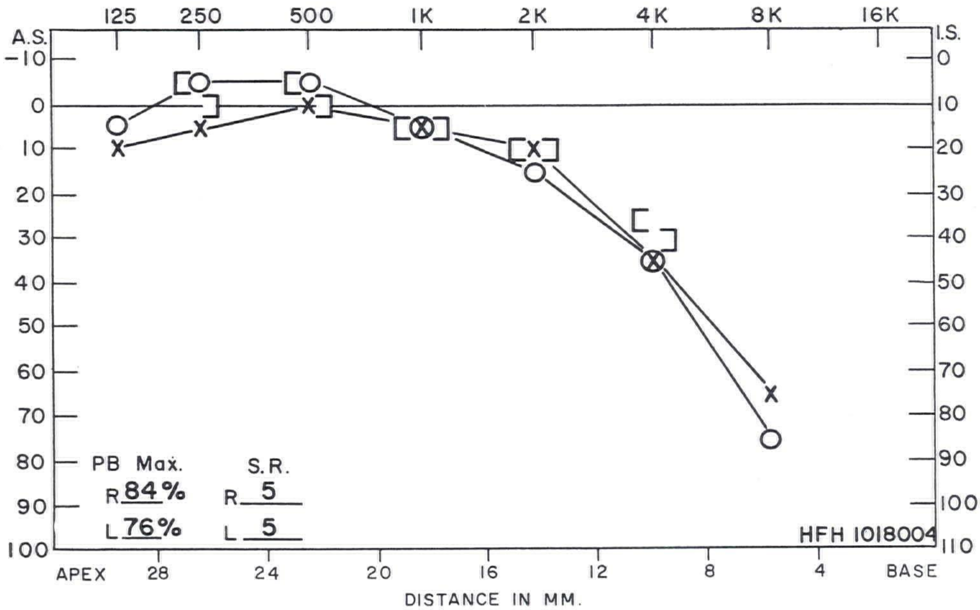

Figure 1
Audiogram showing hightone sensorineural hearing loss.

Examination revealed normal ear drums. He heard the 512 cps tuning fork better by air conduction than by bone conduction on both sides. Audiometry revealed a bilateral symmetrical high tone sensorineural type deafness with speech discrimination scores (PB-Max) of about 80 percent and speech reception thresholds of 5 db. (See Fig. 1)

The whistle shown in Fig. 2 has a cork ball in its cylindrical cavity. This cork ball whirls around when the whistle is blown.

On a sunny day, with little wind, the equipment of Fig. 3 was arranged on the roof parking area of the Henry Ford Hospital garage so as to determine the sound pressure levels produced by the high pitched whistle outdoors, at the entrance of the external meatus. After adjusting the equipment, the operator would then walk over to the microphone stand, a distance of approximately 10 yards, and would position himself so that the microphone was approximately 2 in. in front of the external meatus of his right ear, and blow the whistle.

The analyzer was first adjusted to have a pass band 20 - 35,000 cps to determine the overall sound pressure level. The whistle was blown three times, each blast lasting two seconds. Fig. 4 (upper trace) shows the recording thus obtained. The three blasts "rise" out of a 71 db background noise, which was attributed to highway traffic and perhaps some wind. The overall blast sound pressure level was 101 db in one series and 108 db in another series of tests.

The analyzer was then adjusted so as to pass a narrow band of frequencies only. The center frequency (fc) of this band was then automatically scanned from 200 - 20,000 cps by coupling to the motor of the level recorder which simultaneously moves the recording paper. The analyzer is of the constant percentage band width type, and the octave selectivity was adjusted for 40 db, hence the response was down by 40 db at 2 fc and ½ fc independent of the value of fc; series of blasts were recorded on two occasions, the maximum sound pressure level was 101 db on one occasion (Fig. 4, middle trace) and 108 db on the other (Fig. 4, lower trace). A steady 4000 cps tone of proper intensity with 10 percent second and 3 percent third harmonic content instead of the whistle would produce the envelope of the blasts of Fig. 4, middle trace.

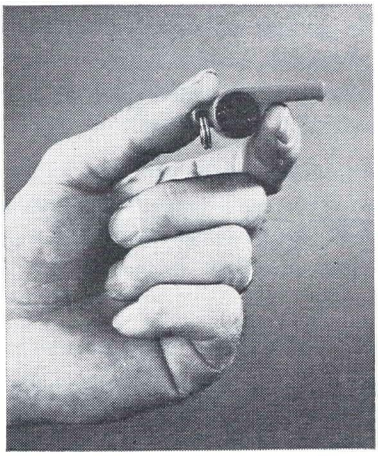

Figure 2
Dog training whistle.

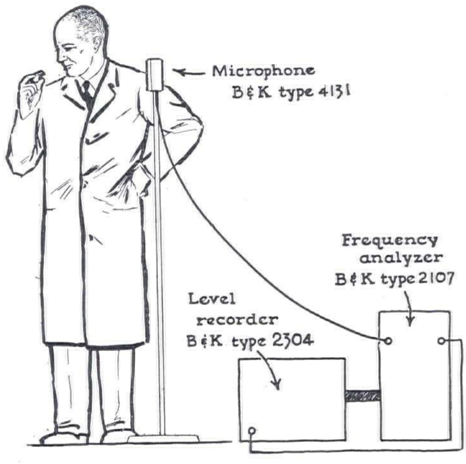

Figure 3
Arrangement of sound recording equipment.

The sound pressure level spectrum of the whistle consist therefore of a sharp 4000 cps peak of 100 - 108 db with second and third harmonic peaks of approximately 80 and 70 db respectively, and those peaks are probably much narrower than suggested by Fig. 4. Following the tests, the operator (H. v. d. E.) experienced a slight subjective sensation of auditory "stuffiness" for several hours and high pitched tinnitus for about 12 hours.

High frequencies are known to be more damaging to the inner ear than low frequencies and for the 4000 cps range the maximum intensity considered to be safe in the military and industry is about 85 db.

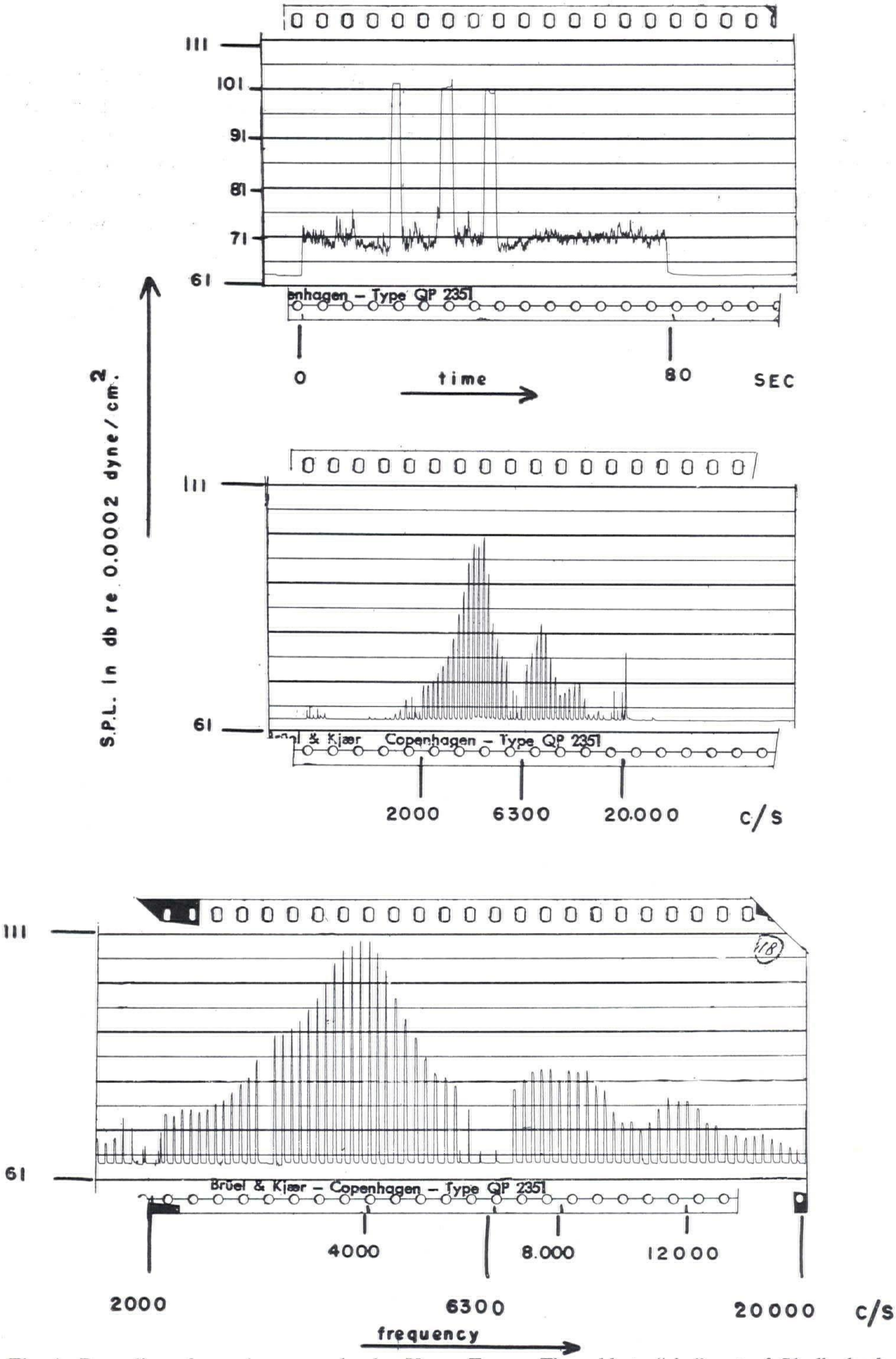

Fig. 4. Recording of sound pressure levels. Upper Trace: Three blasts "rise" out of 71 db, background noise. Passband 20 — 35.000 cps. Paperspeed 1mm/sec. Middle Trace: A series of blasts recorded while scanning the frequency range with a narrow passband. Paperspeed 0.3 mm/sec. Lower Trace: As middle trace but paper speed 1.0 mm/sec.

SUMMARY

A trainer of hunting dogs used a shrill whistle as a command signal. He experienced tinnitus, auditory fatigue and, after several years, a mild, permanent hearing loss. An analysis of the sound spectrum of the whistle revealed overall sound pressure levels of about 101 and 108 db on two separate tests. Narrow band analysis showed a sharp pressure peak at 4000 cps and lesser peaks for the second and third harmonics. Commercially available protective ear plugs of proper size have been prescribed for the patient, and he has been instructed to wear them at all times during exposure to the whistle noise. Fortunately, protective ear plugs are more effective for high frequencies than for low frequencies, and they should prevent further inner ear injury.