E·A·R LOG® 18

Eighteenth in a comprehensive series of technical monographs covering topics related to hearing and hearing protection.

Can Hearing Aids Provide Hearing Protection?

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When employees who wear hearing aids work in noise, they may request to wear their aids, turned off, in lieu of standard industrial hearing protection devices (HPDs). This may be due to comfort (since they are accustomed to their custom hearing-aid earmold), or convenience (since their hearing aids are available for use when needed), or reduced attenuation (which may help them hear better under certain conditions), or because they may wish to occasionally use their aids in the noise. The latter is uncommon since it is generally observed that present-day hearing aids are of little value in noisy environments.[1,2]

The question is: Can an earmold that is part of a hearing-aid system provide adequate hearing protection? If so, the wearer could quickly and easily turn on and use the aid when needed, and yet turn off the aid and continue wearing it to obtain noise reduction as required. This EARLog examines the feasibility of such an approach.[3]

The Earmolds

Six different types of earmolds were evaluated. Three consisted of a standard lucite shell custom earmold with a vent which was either fitted with a plastic plug containing a 0.030" or 0.150" diameter hole, or with one containing no hole at all (unvented). The remaining devices, all of which were unvented, were a full-size in-the-ear aid (ITE), an earmold manufactured from a soft elastomeric material commonly used for high-gain hearing aids (power mold), and a standard E-A-R® plug center bored with a 0.108" diameter hole and fitted with #13 hearing aid tubing. The lucite, power, and foam-plug earmolds were connected to a behind-the-ear aid (BTE) that was fitted with a battery and turned off.

The Procedure

One group of 10 subjects participated in all measurements. One audiologist using a syringe and foam ear dams took all of the earmold impressions. Real-ear attenuation was assessed by the E-A-RCAL℠ Acoustical Laboratory in conformance with ANSI S12.6,4 except as noted below.

To minimize the number of molds that were manufactured only right ears were tested. The non-test (left) ear was occluded with a deeply inserted E-A-R Plug covered by a large volume earmuff cup. This procedure was assumed acceptable since the dual-HPD combination provided at least 6 dB more attenuation at all frequencies than did any of the earmolds in the study.

In certain ear canals temporomandibular-joint motion may cause custom earmolds to imperceptibly back out of the canal, breaking their seal, and thus losing much of their attenuation. Therefore, to provide more realistic data, all subjects exercised their jaws after fitting and prior to actual testing.

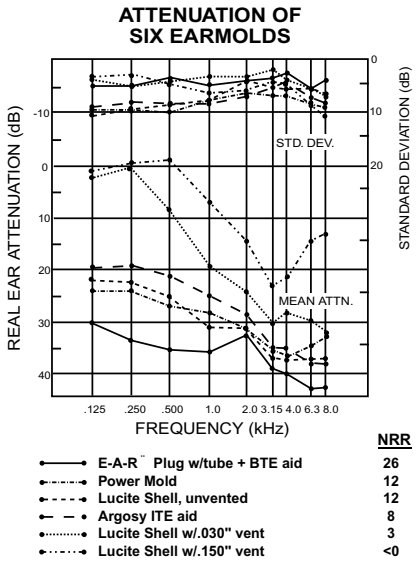

Figure 1

The Results

The real-ear attenuation values (see Figure 1) can be separated into three categories - vented earmolds, which provide less than 20 dB of protection below 2 kHz; unvented earmolds, which provide approximately 20 dB or more protection at all frequencies; and the foam "earmold" which provides approximately 30 dB or more protection at all frequencies.

The foam earmold is compared with an unmodified foam earplug in Figure 2. The loss of attenuation due to the penetration by the tube is from 2 to 4 dB at all test frequencies. A likely cause is sound conduction into the BTE aid or through the walls of the connective tubing, with subsequent transmission into the occluded ear via the orifice in the earplug.

In Figure 3 the average results for the three unvented earmold types in this study are compared to data from our laboratory for a standard high-quality custom earmold designed specifically for hearing protection. The performance is similar as would be expected.

Also shown in Figure 3 are the average data for a group of six different types of custom earmolds (half were lucite and half were vinylflex) that were fabricated and tested by Frank.[5] The average results are shown since the range of mean attenuation values across all six devices was never greater than 8 dB at any one frequency and was typically less than 6 dB. Although all of the earmolds in Frank's study were unvented, the measured attenuation is much closer to that found for the vented earmolds tested in this study.

Since earmold attenuation is so strongly influenced by the tightness and accuracy of the initial ear canal impression,[6] it is likely that the lower values of attenuation reported by Frank reflect different procedures and criteria for

earmold fabrication. He suggested that the primary reason for the reduced attenuation "was related to sound passing through leaks around the traditional earmolds."[5] Thus, depending upon the impression and fabrication procedures, even unvented earmolds may fail to provide adequate noise attenuation.

Discussion

The data in this report indicate that for the typical vented earmold, and even unvented earmolds depending upon how they were fabricated, attenuation is insufficient for all but the most marginal occupational exposures. However for a tightly fitted unvented earmold or when foam earplugs are used as hearing aid earmolds, protection equivalent to standard commercially available earplugs is achievable. If possible, it is best to validate the level of protection by asking the audiologist who fitted the hearing aid to estimate its attenuation using sound field audiometry, i.e. measuring the difference between the individual's unaided, unoccluded thresholds and the occluded thresholds with the aid turned off.

Related Issues

Regardless of the amount of attenuation that is provided by the hearing aid earmold, the aid itself, which usually supplies from 20 to 50 dB of maximum gain, can potentially cause additional noise-induced hearing loss when used in the presence of sustained high-level noise.[7] Although no definitive answers are available, a prudent recommendation is that employees should never operate their aids without the addition of an earmuff (see below) when the sound levels exceed 80 dBA. Whenever hearing aids are worn in noise, careful employee orientation is necessary, and more frequent audiometric monitoring (twice annually) is advised until the stability of the individual's hearing threshold levels can be verified.

When a hearing aid user is required to remove his or her aid and wear a hearing protector, speech messages and some warning signals may be attenuated below the hearing threshold. This effect may be minimized by providing a low-attenuation HPD, one with the minimum attenuation necessary for the exposures in question. Individual counseling is required as well as evaluation of the suitability of the person for the job. For example, in the Air Force minimum hearing sensitivity is specified for certain noise-hazardous occupations.[8]

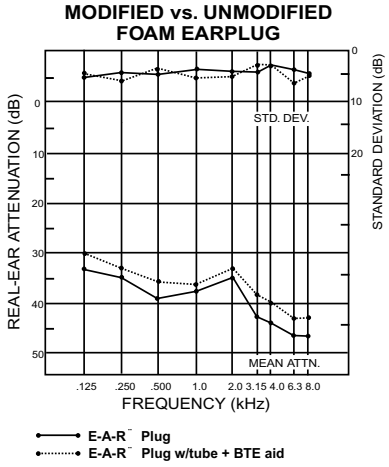

Figure 2

Alternative strategies, but ones that should only be ***considered with caution***, involve the use of hearing aids (primarily ITE versions) worn under earmuffs. Presuming the earmuff is in good condition and properly worn, in certain cases the aid may be adjusted (for reduced gain) to partially compensate for the predominantly high-frequency hearing deficit arising from the combination of sensory loss and earmuff attenuation.[9] The aid may also be used under the earmuff in a ***non***operational mode, but if the earmold is well fit and has minimal venting, the combined attenuation from the two devices can be great enough to render the already hearing-impaired individuals unable to hear the sounds about them.

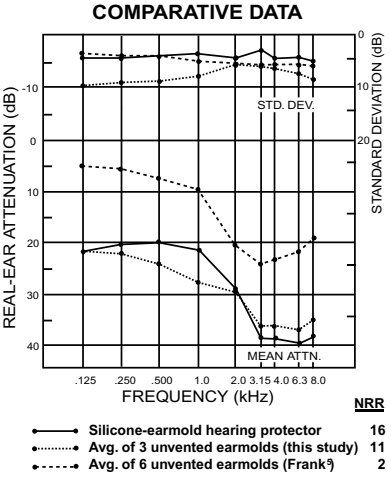

Figure 3

Whatever decision is made concerning the suitability of the earmold for use as a hearing protector, the hearing-impaired individual should be protected. Exceptions may include an individual with a hearing loss so severe that the noise is inaudible, or persons with a conductive loss that exceeds in magnitude the attenuation that a hearing protector could provide.[10,11,12]

Decisions regarding the disposition of hearing-aid users and others with substantial hearing impairments are not clear cut. Even with individual counseling, comprehensive audiological workups, and expert consultation, ideal solutions are elusive. Development of an informed consensus on suitable strategies for protecting the already hearing impaired awaits further laboratory and field research as well as frank and open scientific exchange. Your comments and/or case histories are invited and welcome.

References and Footnotes

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12. OSHA published regulations do not permit such exceptions, but according to J. Barry (Tech Support IH in OSHA Region#3) special cases can be discussed with area directors.

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