OPEN FIT HEARING AIDS

Non-occluding behind the ear hearing aids

Marshall Chasin, AuD., M.Sc., Reg. CASLPO, Aud(C)
Doctor of Audiology
Musicians' Clinics of Canada
Toronto, Ontario

The advantages of non-occluding, or open mold hearing aids, have been known for more than half a century. A number of studies performed in the 1960s and early 1970s demonstrated improved speech intelligibility with non-occluding or IROS (Ipsilateral Routing Of Signal) hearing aids fittings, especially combined with a CROS (Contralateral Routing Of Signal) hearing aid for those with normal hearing in one ear and non-aidable hearing in the other ear. Hearing aid earmolds using an air vent have been used for decades in order to minimize the amount of low-frequency amplification and to minimize the occlusion (or echoey sensation) effect. However, as the vent diameter increases (past 3 mm) there is a significant chance of acoustic feedback (whistling) with a limitation of high-frequency gain. Traditionally, a non-occluding mold or hearing aid was used for those people with essentially normal hearing up to 1000 Hz and with a high-frequency hearing loss. Examples of people with this type of hearing loss may include presbycusis and noise induced hearing loss. For greater hearing losses (especially for those with significant low-frequency hearing loss as well), hearing losses with non-occluding molds would result in a sub-optimal fitting. The occlusion effect (where the high vowels [i] and [u] are artifically increased in sound level) is perceived as a hollow or echoey sensation of one's own voice and has been implicated as a major reason for dissatisfaction with hearing aids. It is therefore reasonable to minimize this effect with a larger vent, while balancing this requirement with trying to obtain sufficient higher frequency amplification; too large a vent results in feedback and too small a vent results in the occlusion effect. Being an audiologist sometimes calls for a balancing act between two undesireable phenomena.

Even though the modern form of non-occluding behind the ear (BTE) hearing aids have been in existence for only the last 5 years or so, they already account for approximately 20% of the total number of hearing aids sold. With the advent of improved digital signal processing techniques, significant improvements were made in the war against feedback- circuitry referred to as "feedback management systems". This circuity would allow the use of a large vent (one that minimizes the occlusion effect) and also allow more high-frequency amplification necessary for improved speech intelligibility before feedback was encountered. Feedback is still an issue, but is gradually coming under control. With this innovation, we now have hearing aids that can provide significant high-frequency amplification with no occlusion effect. In most cases, these open mold, or non-occluding BTE, hearing aid fittings are "acoustically invisible" in the sense that those who wear them sometimes forget that they are wearing anything at all.

There are currently three main approaches used for countering the deleterious effects of feedback and these are found in all styles of modern hearing aids. One is to simply reduce the overall gain in the hearing aid whenever feedback is encountered. Although this overall reduction may seem to be a rather blunt tool (reducing gain for all frequencies despite the fact that feedback is typically only in the 3000 Hz region) it can have some advantages when listening to music. If feedback is encountered, the relative balance between the low-frequency fundamental energy and higher frequency harmonics is maintained. A second approach uses a notch filter that can "search and destroy" the offending feedback frequency but leave other frequencies intact. Many hearing aids use such a technique although a criticism is that there may be a fuzzy or blurry sound as the notch moves around removing parts of the amplifed speech or music spectrum. The third, and most common approach, is to use phase cancellation. The hearing aid generates a signal that is identical to the feeback frequency that is detected, but is 180 degrees out of phase. It is like a wave in an ocean moving in one direction intersecting with a wave going the other way. When they overlap, there will be a moment where the waves have cancelled leaving a smooth waveless ocean. The only drawback of this approach is that the offending signal may be very short and not feedback at all. For example, the sound of a flute can be confused with feedback whistling. Once the note of the flute stops, the hearing aid may for a moment still be generating the out of phase signal which is no longer cancelled. Hearing aid wearers may notice a short "chirping" sound. Innovations are available to counter this artifact by either limiting the feedback management system to only very high-frequencies, or by using a slow and fast detector that helps to distinguish true feedback from important environmental, speech and music cues.

There are two main types of non-occluding BTE hearng aids on the market. One uses a very thin tube that transmits the sound to a non-occluding earmold much like conventional BTE hearing aids. The other uses a thin wire that extends down inside the thin tubing terminating in a receiver placed directly in the ear canal opening. There are subtle differences between the two approaches with the receiver in the ear canal version allowing slightly more high-frequency gain and output than the more conventional BTE tubing approach. I usually explain non-occluding BTEs to my patients as follows:

"Remember your mother's old hearing aids that went over the ear with an earhook and an earmold? Well, we have recently found a way that throws away the bad stuff and keeps all of the good stuff. There is a small hearing aid that fits behind the ear and, instead of an earhook and thick tubing, a very thin wire-like tubing goes over the ear and ends in the ear canal without plugging it up."

Oticon Delta - Examples of a non-occluding BTE

In both cases, the tubing that connects the small BTE portion of the hearing aid to the ear is very narrow and typically follows the natural crease of the ear. In most cases, a non-occluding BTE is less visible that a more conventional custom hearing aid that fits in the ear, including the very small completely in the canal (CIC) type.

Despite the fact that non-occluding BTEs are typically only recommended for mild to moderate high-frequency hearing losses with relatively good hearing in the lower frequencies, an application may be made with musicians who play in high level musical environments. As the input gets more intense, less amplification is needed. Part of this derives from the equal loudness contours (Fletcher-Munson curves) and implies that with loud music, a hard of hearing musician may only need a slight boost in the higher frequencies to get the full spectrum of sound. For these people, an open mold BTE which only provides 15 or 20 dB of gain may be more than sufficient, despite having a moderate level hearing loss.