Critical Review: In individuals with sensorineural hearing loss, are there benefits of open-canal hearing aid fittings relative to those of traditional fittings?

Durrer, K.
M.Cl.Sc. (Aud) Candidate
School of Communication Sciences and Disorders, U.W.O.

This critical review examines the benefits of open-canal hearing aid fittings relative to those of traditional fittings. The relative benefits of open-canal fittings have been described using varying parameters; the occlusion effect, aided sound localization and subjective measures have all been used to demonstrate the advantages of open-canal fittings relative to traditional hearing instrument fittings. Overall, research suggests that fitting patients with open-canal hearing instruments, when appropriate, does decrease the occlusion effect, improve aided sound localization abilities, and leads to an overall increase in subjective patient satisfaction.

Introduction

Open fitting hearing aids have re-emerged in the hearing aid industry with resounding popularity. One survey conducted in January 2006 estimated that 17% of hearing aid fittings were open (Mueller, 2006), with the percentage of open-canal hearing instruments dispensed on the rise since then.

Traditionally, hearing aids have occluded the ear canal in order to increase the sound pressure level of the signal arriving to the tympanic membrane and reduce the risk of acoustic feedback. However, occlusion of the ear canal has several disadvantages, such as the occlusion effect, lost localization cues, poor sound quality and discomfort.

While open-canal hearing instruments have been available for decades, improved digital signal processing (DSP) technology has made open fittings possible for a larger portion of hearing loss configurations. In particular, advances in acoustic feedback reduction algorithms have made modern open-canal hearing instrument fittings feasible. Sophisticated feedback reduction algorithms are an integral part of open-canal hearing aids, allowing them to provide 8 to 15dB of additional gain before entering the audible oscillatory state (Parsa, 2006).

The many benefits of open-canal fittings that have lead to their rise in popularity have been described by Mueller (2006): improved comfort of fit, cosmetics, sound quality, localization, ease of repair/maintenance, intelligibility, high frequency gain and reduction of the occlusion effect. Many of these benefits are a result of the design of these products; leaving the ear canal open allows for air circulation as well as un-altered sound information to enter the ear canal.

However, while the numerous advantages of open-canal hearing aids over traditional fittings have been theorized, little research has been conducted to verify these benefits. The high dispensing rate must be validated by evidence supporting the advantages of open-canal hearing instrument fittings. Hence, clinicians need to be critically examining the validity of hearing instrument products before prescribing the technology.

Objectives

The primary objective of this review is to critically evaluate existing literature examining the benefits of open-canal hearing instruments relative to traditional fittings. A secondary objective is to critically evaluate the various measurement tools used to describe the advantages of open fittings.

Methods

Search Strategy

Computerized databases, including MEDLINE-OVID, CINAHL, and PubMed, were searched using the following strategy:

((open-canal hearing aid) OR (open-fit hearing aid) OR (open hearing aid) AND (benefit) OR (advantage))

No limitations were applied to these searches. In addition, counsel with Dr. Seewald revealed additional research articles.

Selection Criteria

Studies included in this critical review had to examine the benefits/advantages of open-canal hearing instruments relative to traditional fittings.

No limitations were placed on the measurement tools used, or the demographics of the research participants.

Data Collection

Results of the literature search yielded the following types of articles congruent with the aforementioned selection criteria: within subjects experimental design, between subjects experimental design, and mixed experimental design.

Results

The Occlusion Effect

Jespersen et al. (2006) evaluated the subjective occlusion ratings of participants who were experienced bilateral hearing aid users and compared them to those who had normal hearing. Ten experienced bilateral hearing aid users with mild-to-moderate sloping sensorineural hearing loss and a reference group consisting of ten normal hearing individuals were recruited.

The participants were asked to rate the naturalness of their own voice while wearing earmolds of varying vent sizes in both the unilateral and bilateral conditions. The vent sizes evaluated were conventional earmolds with parallel vents, completely-in-the-canal (CIC) dummy hearing aids, shell type earmolds with a novel vent design (FlexVent earmolds), and non-occluding silicone eartips.

It was revealed through statistical analysis that both groups rated their own voice as sounding equivalent to un-occluded (corresponding to "very natural") when wearing either one or two silicone eartips; this difference was statistically significant. The silicone eartip condition was the only one where the participants rated their own voices equivalent to un-occluded; in all other conditions, varying degrees of occlusion were reported.

The research study conducted by Jespersen et al. (2006) utilizes a valid experimental design. However, the study looked at a small number of participants and no experimenter or participant blinding was used. In addition, the participant recruitment procedure was not discussed; participant selection bias may have occurred.

Aided Sound Localization

The study conducted by Noble et al. (1998) was aimed at examining the effect of earmold variation on localization ability in people with sensorineural hearing losses whose unaided performance on such a task was better than when using their own hearing aids. Recent records of an Australian Hearing Services clinic were scrutinized to identify people with normal low-frequency hearing combined with bilateral high-frequency sensorineural hearing loss and who were fitted with bilateral behind-the-ear (BTE) hearing aids. Eighteen people were identified and tested for unaided versus aided localization ability. Of the eighteen, nine showed poorer aided performance and were thus included in the study. These criteria indicated that the negative effect on localization was due to the hearing aids, and was not a reflection of poor overall localization abilities.

The participants completed localization tasks wearing their own earmolds (occluding), open earmolds, and "sleeve" earmolds. It was found that aided localization in the participants was restored to unaided levels using the open earmolds. This finding was validated through statistical analysis. The experimenters theorized that the most likely information for localization provided by an open canal hearing aid fitting is the undistorted low-frequency time/phase differences.

Noble et al. (1998) utilized a valid experimental design in this research study. However, only a small number of participants were recruited to participate in the study.

Subjective Measures of Satisfaction

Gnewikow and Moss (2006) directly compared satisfaction with open canal fittings to non-open canal fittings on several outcome measures. This study utilized four measures of hearing aid outcomes: the Satisfaction with Amplification in Daily Life (SADL), the International Outcome Inventory for Hearing aids (IOI-HA), an empirically designed questionnaire and return-for-credit data. These outcome measures were mailed out to a select group of hearing aid users that received their hearing aids from the Vanderbilt Bill Wilkerson Center. Through the use of mailed out surveys, 338 hearing aid users were recruited, among them 97 had open-canal hearing instruments while the remained were fitted with closed canal devices.

It was found that participants fitted with open-canal hearing aids reported greater satisfaction on the Negative Features subscale of the SADL when compared to users fitted with

traditional amplification. Additionally, on the Open-Canal Questionnaire, participants wearing open-canal hearing instruments scored better on the questions of occlusion than did the non-open canal group. All other areas failed to reach statistical significance, though the scores on every measure were better for the open-canal subjects when compared to the traditionally fit group.

Gnewikow and Moss (2006) collected information for their study largely through the use of mailed surveys. While the utilization of well designed surveys can provide vital information for future hearing aid fittings, bias may be seen in those that completed the surveys and those that chose not to. Moreover, the empirical questionnaire developed for this study has not been tested for validity or reliability. Finally, the group of participants was recruited from one centre only.

Discussion

The results of the aforementioned studies validate many of the theorized benefits of open-canal hearing instruments. Though various measurement tools were utilized in varying studies, all showed significant benefits of open-canal hearing aids not seen in traditional fittings.

All of the studies evaluated used valid and reliable measures of a portion of the benefits open-canal hearing aid fittings offer, excepting the empirically designed questionnaire utilized in the study by Gnewikow and Moss (2006). Both subjective and objective measures of the benefits of open-canal fittings were used, from objective measurement of localization abilities, to subjective ratings of one's own voice, to survey outcome measurement.

However, due to the small number of participants in both the Jespersen et al. (2006) and the Noble et al. (1998) studies, these results may not be generalized to the overall population. Moreover, all the studies included in this review looked at individuals fitted with open-canal hearing instruments who had high frequency hearing loss. With improvement in the fitting ranges of open-canal products, people with greater degrees of low frequency hearing loss may be fitted with these hearing instruments; this greater fitting flexibility may have implications in the benefits derived from open-canal hearing instruments.

Conclusion

Outcomes from the studies explored in this critical review reveal significant benefits of open-canal hearing instrument fittings relative to traditional fittings. Therefore, when appropriate, open-canal hearing instruments should be fitted to take advantage of the many benefits these fittings have to offer.

Recommendations

Given the assembled research materials, there is significant evidence supporting the benefits of open fit hearing instruments. Patients meeting the selection criteria (i.e. fitting range of the hearing instrument) will most likely experience greater benefit from an open canal hearing aid relative to a traditional fitting in the areas of occlusion, localization, and a subjective, overall positive fitting experience.

More research is needed that looks at hearing aid outcomes comparing open and closed canal fittings using both subjective and objective measurement tools. With studies that use more participants, and a more experimentally sound procedures (i.e. blinding, sampling methodology), a higher level of significance and power will be achievable.

In addition, further research should be directed at comparing the various adaptations of these devices to determine the benefits and limitations of the numerous open-canal hearing instrument configurations.

References

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