Critical Review: Do adult cochlear implant (CI) recipients over 70 years of age experience similar speech perception/recognition gains postoperatively in comparison with adult CI recipients under the age of 70?

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This critical review examines if elderly adult cochlear implant (CI) recipients over 70 year of age experience decreased postoperative speech perception/recognition scores in comparison to younger adult recipients less than 70 years of age. Study designs included: two retrospective cohort studies, a cross-sectional study, and a case-control study. These studies seem to suggest that elderly CI recipients may experience age-related differences which result in decreased postoperative speech perception/recognition scores in comparison to younger recipient groups. These age-related differences could be the result of auditory system degeneration (loss of spiral ganglion cells), central presbycusis, or other factors. Despite these differences researchers conclude that the elderly groups do experience auditory benefit and should be considered as candidates for cochlear implantation in the future.

Introduction

Cochlear implantation involves the surgical implantation of an electronic device into the cochlea in order to provide sound information to an individual who is considered to be deaf or has a profound hearing loss. In order to qualify as candidates for cochlear implantation, patients have to meet certain requirements, such as the lack of benefit from traditional amplification. Cochlear implantation has been found to be a useful tool for the rehabilitation of individuals with sensorineural hearing loss.

In the past, the elderly have been thought to be less than ideal candidates for implantation when compared to younger cohorts due to degeneration of the auditory pathways related to age, "central presbycusis" (progressive central auditory dysfunction), and other factors such as increased possibility of co-morbidities and cognitive/intellectual abilities (Waltzman, Cohen & Shapiro, 1993). These factors affect the elderly population in particular, and have in the past been thought to some extent limit the benefit that could possibly be derived from cochlear implantation. Cost-effectiveness has also been suggested as a possible difficulty, as implantation and subsequent rehabilitation is costly and therefore must be provided to those for whom the most benefit is realized.

Despite initial misgivings among CI researchers, adult recipients under 70 years of age have been shown to benefit from cochlear implantation after meeting candidacy requirements (Sprinzl & Riechelmann, 2010) and have shown increased speech perception/recognition scores postimplantation (Noble, Tyler, Dunn & Bhullar, 2009). Recent studies suggest that older-age adult recipients experience similar auditory benefit (Eshraghi et al., 2009 & Williamson, Pytynia, Oghalai & Vrabec, 2009).

Objectives

The primary objective of this review is to critically evaluate existing literature comparing postoperative speech perception/recognition scores for older-age (≥ 70 years) and younger-age (<70 years) adults, as these scores are often used as measures of auditory benefit. The secondary objective is to come to a conclusion regarding the possibility of age related factors influencing postoperative speech perception/recognition scores for older-age vs. younger-age cohorts of CI recipients.

Methods

Search Strategy

Computerized databases Pubmed, Scopus, and Embase were searched using the following search strategy:
[(cochlear implant) AND (elderly) OR (old) OR (geriatric) AND (perception) OR (recognition)]

Reference lists for the referenced articles were also reviewed for possibly relevant articles.

Selection Criteria

In order to be included in this critical review studies had to compare an older-age (≥ 70 years) and younger-age (<70 years) adults group of CI recipients using measures of speech perception/recognition. Studies were not excluded on the basis of methodological design.

Data Collection

Articles meeting selection criteria that were chosen for inclusion in this literature review include: nonrandomized retrospective cohort study (2), case-control study (1), and cross-sectional study (1). All of these studies come from research groups independent of one another.

Results

Retrospective Cohort Studies

Chatelin et al. (2004) reviewed auditory outcomes for two groups of CI recipients from tertiary referral centers. All patients met criteria for implantation and had undergone multichannel cochlear implantation with Clarion or Nucleus implants. In the elderly group, the age of implantation ranged from 70 to 91 years with a mean of 76 years. Length of deafness prior to implantation ranged from 1 to 52 years with a mean of 6 years. The mean age of implantation for the younger group was 48 years and ranged from 24 to 69 years. Length of deafness was not provided for the randomly selected younger group.

Open-set word and sentence recognition was used as a measure of auditory performance for 65 patients ≥70 years of age at the time of implantation and for a second group of 101 patients <70 years of age, with each patient being their own control as in a repeated measures single-subject experiment. Aided recognition scores were obtained preoperatively and postoperative recognition scores were measured at 3, 6, and 12 months. Recorded versions of Monosyllabic Consonant-Nucleus-Consonant (CNC) words, Central Institute for the Deaf (CID) sentences, and Hearing in Noise Test (HINT) sentences were used as measures of speech perception ability.

In comparison to aided preimplantation scores, both groups demonstrated significantly improved speech perception abilities at 3, 6, and 12 months postimplantation. The younger group showed a tendency to outperform the older group, achieving higher 12 months postimplantation speech perception scores on all three measures. Mean 12 month postimplanation scores for the young group vs old group are 78% and 62% for the CID, 45% and 36% for the CNC, and 79% and 62% for the HINT (respectively). A two-tailed chi-square analysis was completed which indicated that the rate of change between the two groups was significantly different for CNC scores ($p=0.03$) but not for CID or HINT scores ($p=0.07$ for both). These results indicate that elderly individuals ≥70 do experience significantly increased speech perception postimplantation, with the tendency to be outperformed by younger individuals <70 years of age.

Poissant, Beaudoin, Huang, Brodsky, & Lee (2008) compared postimplantation speech perception in three groups: elderly CI recipients ≥70years of age (n=9), younger CI recipients ≤60 years of age (n=8), and elderly hearing aid (HA) users ≥70years of age (n=9). Speech perception in quiet and in noise was tested using a combination of CNC monosyllables, CUNY sentences, and HINT sentences. The groups were matched for age, duration of hearing loss, and length of CI use.

When comparing performance on speech perception measures, researchers report that the elderly HA group tended to outperform both CI groups. For monosyllabic words, the

elderly HA users performed better than the elderly CI group (92% vs 44%, p=0.000) and the younger CI group (53%, p=0.002). The elderly HA users also performed better than the elderly CI group in quiet (99% vs 64%, p=0.017) and noise (81% vs 32%, p=0.016). Elderly and younger CI groups did not perform significantly different on any measure of speech perception ability. This would seem to indicate that speech perception abilities of elderly (≥70years of age) and younger (≤60 years of age) CI recipients are similar, and that both groups have decreased abilities in comparison to HA users even when matched for age and duration of hearing loss.

Case Control Studies

Sterkers et al. (2004) included an elderly subset of 8 CI recipients ≥70years of age in their study of pre and postoperative (22.5 months) open-set sentence recognition. The remaining recipients were <70 years of age but >60 years of age. Pre and post operative speech recognition scores were reviewed retrospectively in order to determine if recipients had received benefit from cochlear implantation. As expected, Sterkers et al. determined that postoperative speech recognition was significantly improved when compared to preoperative scores for both the elderly and the younger subsets (p=0.0032 for the entire group). Recipients ≥70years of age achieved postoperative speech recognition scores similar to those of the younger recipients. Sterkers et al. conclude that these results indicate that elderly CI recipients are able to benefit significantly from implantation, regardless of age-related difficulties such as auditory processing problems. However, researchers draw from other studies and comment that when sentences were presented at an increased rate or in the presence of noise, older groups performed significantly worse than younger groups. Specific scores were not provided.

Cross Sectional Studies

Vermeire et al. (2005) performed speech recognition testing using phonetically balanced monosyllabic word lists (NVA list) for 89 CI recipients. As they intended to examine the influence of age at implantation, three groups were formed: a young group (<55 year of age, mean age = 42years, n=33), middle-age group (between 56 and 69 years of age, mean age = 62 years, n=31), and a geriatric group (≥70 years of age, mean age = 74 years, n=25). Preoperative speech recognition scores were assessed at 65 dB SPL using TDH-39 headphones, postoperative speech recognition scores were assessed in soundfield. Postoperative scores were assessed at 3, 6, 12, and 24 months.

In comparison with preimplantation scores, all three groups showed improved speech recognition scores postimplantation. Mean scores improved from 7% to 68% for the younger group, from 4% to 59% for the middle age group, and from 4% to 46% for the geriatric group (pre vs postimplantation). A linear regression analysis demonstrated that only the middle-aged group showed significant improvement over time postimplantation (p=0.027). A repeated-measures ANOVA demonstrated that the improvement in postimplantation speech recognition scores was not significantly different between the three groups (interaction p=0.115), but that there was a significant difference between groups (p=0.016). The geriatric group was shown to have the poorest speech recognition both pre and postimplantation. Vermeire et al. state that these results indicate that elderly adult CI recipients can derive benefit from implantation, although final postimplantation speech recognition scores do appear to be slightly less than that of younger groups.

Discussion

Chatelin et al.'s (2004) use of a psychological component in the selection criteria for implantation would have allowed maximal benefit to be derived by those who were implanted. The relatively large number of subjects in each group increased validity, as did the study design itself. It would have been of interest for researchers to include the length of deafness of the younger group, as this is of interest and could possibly have an effect on the results in that a shorter length of deafness could affect the status of the auditory pathway and individual's ability to make use of acoustical information provided by the implant. Although

the nature of the study did not allow for blinding or randomization, the methods of the study may be termed valid. Testing with measures simulating both quiet and noisy environments, as well as allowing implant users to use their preferred speech processing strategy all contribute to the validity. The statistical manipulations carried out were such that differences between the groups were adequately described. The study provided a second level of evidence with good validity overall. These results suggest that adult CI recipients over 70 years of age do experience speech perception/recognition gains postoperatively in comparison with younger CI recipients, but that the younger groups tends to receive more benefit. This difference was significant for only one of the three measures.

Poissant et al. (2008) presented a well-formulated rationale for their study, and the inclusion of an elderly HA group was good for comparison purposes, although this group was not considered to be CI candidates. As recognized by Poissant et al. (2008) the numbers in each of the groups was quite small and could limit validity, as there can be a large amount of variability in results between CI recipients. It was not stated whether the CI users were given a choice of processing strategies, or if speechreading was allowed. Both of these factors could affect results. The level of evidence provided was secondary. The statistical manipulations performed were sufficient to describe the differences between groups. Overall, this study is suggestive of younger and older CI recipients performing similarly of measures of speech perception in quiet and noise. Due to the small number of participants, this study is helpful in supporting other findings rather than standing alone as compelling evidence of benefit derived from implant use.

Similarly to Poissant et al. (2008), Sterkers et al. (2004) included an elderly adult group with few subjects, limiting validity. Also, follow-up measures were completed at different times for different participants, up to five years postimplantation. Although researchers stated that CI recipients older than 70 years performed similarly to patients younger than 70 years, only mean scores with associated standard deviations were given. Statistical manipulations were inadequate and limit any conclusions that may be drawn from the study. Unlike other studies, there was no testing completed in noise, limiting generalizibility to real world situations. Although the level of evidence in this study is similar to that found in other studies, validity is limited and evidence is not compelling. It may be suggested by this study that in general CI recipients over 70 years of age can receive similar benefit to younger old-age groups, but this study cannot comment if the two groups receive significantly different benefit due to lack of adequate statistical manipulations.

Vermeire et al. (2005) recruited participants from a tertiary referral center, using standard selection criteria, and also screening for dementia in order ensure the best candidates possible were included in the study, similar to Chatelin et al. (2004). Such criteria ensure that extraneous variables are not responsible for results. This study was well formulated and included relevant statistical manipulations. The number of subjects in each group is sufficient, however validity suggestive rather than compelling due to the fact that testing in noise was not included. The level of evidence was similar to previous studies. This study is highly suggestive of CI recipients over the age of 70 years deriving benefit from implantation, although postimplantation scores are significantly less than those of recipients under the age of 70 years. However, it must be remembered that there was no significant difference in the improvement derived from implantation.

Clinical Implications

A review of available research indicates that elderly adult CI recipients over 70 year of age experience similar improvement in postoperative speech perception/recognition scores vs. preoperative scores in comparison to younger adult recipients less than 70 years of age. The difference between elderly adult and younger adult postimplantation scores is most likely a caused by the elderly adults CI

recipients having generally lower preimplantation scores, as demonstrated by Vermeire et al. (2005). However, it has been consistently demonstrated that elderly adults over 70 years of age do experience benefit from cochlear implantation. Younger age adults do tend to score higher on postimplantation measures, but in general this difference was small and nonsignificant for studies with the highest validity.

The improvement in postimplantation speech recognition/perception scores applies to stimuli presented in both noise and in quiet. Sterkers et al. (2004) suggested that there was some indication that increasing the speed of presentation of stimuli could cause the performance of elderly adult CI recipients to decrease and become significantly poorer than younger adult performance. Exploring the effect of an increase in presentation speed on the performance of elderly adult CI recipients is a topic for future research.

Despite concerns from researchers regarding age-related differences in performance and possible surgical complications related to age, it is clear that elderly adults do experience substantial benefit from cochlear implantation, and that this increase in performance is in fact comparable to that experienced by younger adult recipients. Cochlear implantation is therefore a viable option for the rehabilitation of elderly adults over 70 years of age who are suitable candidates for cochlear implantation.

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