IS HEARING PRESERVATION COCHLEAR IMPLANTATION IN THE ELDERLY DIFFERENT?

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Abstract

Background: Hearing preservation cochlear implantation has become commonplace, giving patients who are poor hearing aid candidates but who have significant residual hearing an opportunity to take part in the hearing world. Hearing preservation cochlear implantation has been extended into pediatric populations, but little attention has been paid to geriatric implantation.

Material and Methods: Cochlear implant candidates with residual low frequency hearing implanted between 2009 and 2011 were studied. Pure tone average was evaluated pre- and post-operatively and plotted against patient age.

Results: There was a statistically significant relationship between loss of hearing (PTA before and after implantation) and age.

Conclusions: Hearing preservation cochlear implantation is feasible in the elderly but there is a slightly larger change in hearing. We review factors that may affect hearing preservation outcomes in the elderly.

Keywords: cochlear implantation • hearing preservation • aging • presbycusis

Background

Recognition that preservation of residual low frequency hearing improves cochlear implant (CI) function has been widely described (Gstoettner et al., 2004; Kiefer et al., 2004; Dorman and Gifford, 2010). Among patients, the elderly represent a population where down-sloping hearing losses with poor speech discrimination are common, and hence they are a group from which potential hearing preservation CI patients may be recruited. A key question is whether the elderly have the same outcomes in terms of hearing preservation as younger patients. To examine this we looked at changes in hearing after implantation as a function of age; we then examined the correlation between age and change in pure tone average. We also looked at cochlear implant outcomes as a function of age for hearing preservation patients. We discuss some of the potential causes of observed differences between the patient populations.

Methods

Subjects and outcomes measures

Informed consent was obtained prior to testing, and the protocol was approved by the University of Kansas Medical Center human subjects board. A total of 18 patients with residual hearing between 125 and 500 Hz (5 males and 13 females) were implanted between 2009 and 2011. Ages ranged from 26 to 84 with a mean age of 63.2 years. All candidates fell within Food and Drug Administration (FDA) or Medicare guidelines for implantation. Prior to implantation, all patients underwent blood testing to screen for autoimmune inner ear disease and had an MRI scan to rule out the presence of retrocochlear disease.

Surgical approach

The extended round window approach was used in all cases. After performance of a mastoidectomy and facial recess (posterior tympanotomy) approach to the middle ear, all bone dust was irrigated out of the wound. Hemostasis was obtained and 0.5 ml of Decadron (10 mg/ml) was applied to the round window niche. The bony overhang of the round window niche was then carefully removed with a 1 mm diamond burr and the round window clearly visualised by testing the round window reflex. The wound was once again irrigated and Healon was used to cover the round window (RW). The RW was then opened with a small pick and the implant electrode carefully inserted. All patients were implanted with a Med-El medium (M) electrode array. Pure tone thresholds were obtained before surgery and 2 weeks post-operatively using insert earphones. The change in pure tone average (PTA) was calculated at 250, 500, and 750 Hz. Initial PTA immediately after surgery for all patients was less than 40 dB.

Results

As seen in Figure 1 there was a linear relationship between age at implantation and change in hearing in the low frequencies (r^2=0.52; p<0.05). When arbitrarily divided at age 65, the average change in PTA for the younger patient group (average age =46.5) was 13.4 dB and the older patient (average age =74.5) group was 19 dB (p=0.12). As seen in the box plot of this data (Figure 2), the range

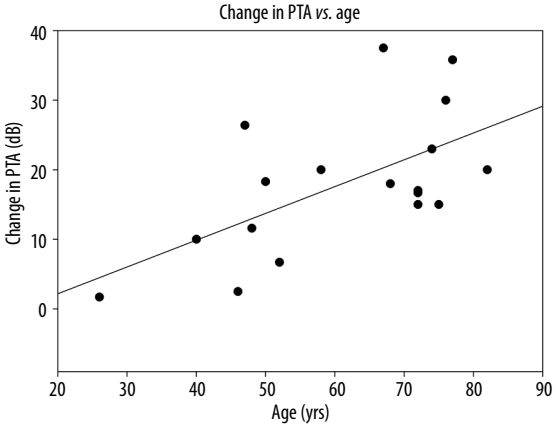

Figure 1. Scatter plot of change in pure tone average *versus* age. There is a linear relationship between patient age at time of implantation and degree of hearing preservation.

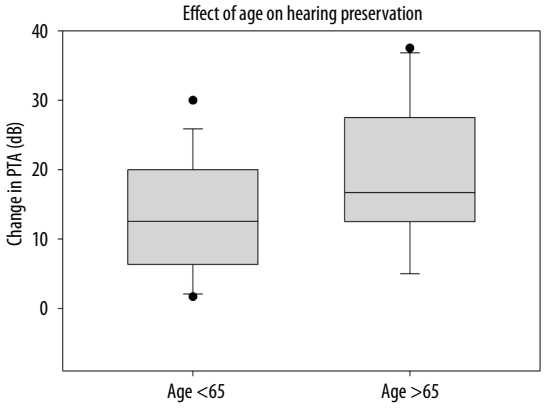

Figure 2. Box plot of average change in hearing for patient age less than and greater than 65. Younger patients tend to have slightly less change in hearing and older patients demonstrated a wider range in change in residual hearing after implantation; however, this was not statistically significant.

of data distribution is broader for the older age group, resulting in a large standard deviation.

Discussion

The development of reliable approaches for hearing preservation cochlear implantation has led to a rapid expansion of cochlear implantation to novel patient populations (Skarzynski et al., 2010). The audiologic configuration that makes patient candidates for hearing preservation implantation is common in the elderly (Hoffman et al., 2012). A recent review of cochlear implantation in the elderly suggests that earlier implantation, when patients have less hearing loss, may result in better hearing outcomes (Lin et al., 2012). Successful expansion of hearing preservation implantation into this population thus represents an important goal.

Overall, our data suggest that hearing preservation is feasible in the elderly and that, on average, hearing preservation outcomes are similar to younger patients (Figure 2). However, when examining the data more closely, the range of hearing loss after implantation is higher in older patients and regression analysis does suggest that, as age increases, the amount of hearing loss after implantation also increases (Figure 1). As we have previously reported, we did not see any significant difference in implant function between our patients based on age (Prentiss et al., 2010); therefore, despite slightly increased loss of low frequency hearing, hearing preservation implantation is still a valuable intervention. Accumulation of patient numbers may in future allow us to divide patients into 10-year cohorts, allowing us to better stratify risk based on age.

The relationship between age and central auditory dysfunction has been well documented, but little is known about the effects of age on the cochlea's sensitivity to damage. A potential source of age-related sensitivity to damage is mitochondrial function within the inner ear. Damage to mitochondrial DNA has been documented to occur in all regions of the inner ear as age increases (Seidman et al., 2002; Yamasoba et al., 2007; Someya and Prolla, 2010; Crawley and Keithley, 2011). The accumulation of mitochondrial DNA damage can lead to sensitivity to further stress and subsequent induction of apoptosis (Fariss et al., 2005). This opens the possibility that completely different protective molecules that stabilise mitochondria could be applied to improve our hearing outcomes in the elderly.

Conclusions

Hearing preservation cochlear implantation is feasible in the elderly although slightly higher rates of hearing loss may be observed compared to younger patients.

References:

1. Crawley BK, Keithley EM: Effects of mitochondrial mutations on hearing and cochlear pathology with age. Hear Res, 2011; 280: 201–8
2. Dorman MF, Gifford RH: Combining acoustic and electric stimulation in the service of speech recognition. Int J Audiol, 2010; 49: 912–19
3. Fariss MW, Chan CB, Patel M et al: Role of mitochondria in toxic oxidative stress. Mol Interv, 2005; 5: 94–111
4. Gstoettner W, Kiefer J, Baumgartner WD et al: Hearing preservation in cochlear implantation for electric acoustic stimulation. Acta Otolaryngol, 2004; 124: 348–52
5. Hoffman HJ, Dobie RA, Ko CW et al: Hearing threshold levels at age 70 years (65-74 years) in the unscreened older adult population of the United States, 1959–1962 and 1999–2006. Ear Hear, 2012; 33: 437–40
6. Kiefer J, Gstoettner W, Baumgartner W et al: Conservation of low-frequency hearing in cochlear implantation. Acta Otolaryngol, 2004; 124: 272–80

7. Lin FR, Chien WW, Li L et al: Cochlear implantation in older adults. Medicine (Baltimore), 2012; 91: 229–41
8. Prentiss S, Sykes K, Staecker H: Partial deafness cochlear implantation at the University of Kansas: techniques and outcomes. J Am Acad Audiol, 2010; 21: 197–203
9. Seidman MD, Ahmad N, Bai U: Molecular mechanisms of age-related hearing loss. Ageing Res Rev, 2002; 1: 331–43
10. Skarzynski H, Lorens A, Piotrowska A, Skarzynski PH: Hearing preservation in partial deafness treatment. Med Sci Monit, 2010; 16(11): CR555–62
11. Someya S, Prolla TA: Mitochondrial oxidative damage and apoptosis in age-related hearing loss. Mech Ageing Dev, 2010; 131: 480–86
12. Yamasoba T, Someya S, Yamada C et al: Role of mitochondrial dysfunction and mitochondrial DNA mutations in age-related hearing loss. Hear Res, 2007; 226: 185–93