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Hearing Preservation in Partial Deafness Treatment in Children

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Topic: Audiology

Keywords: Residual Hearing

Introduction: Several studies have shown that with appropriately designed and inserted electrodes, acoustic hearing can be preserved in the majority of subjects during cochlear implant (CI) surgery. Having increasingly higher number of cochlear implant patient with hearing preserved, there is a need for hearing preservation classification. The aim of this retrospective study was to apply the HP classification, which was recently proposed by the group of HEARRING centres, in assessment of patients with low frequency hearing after Partial Deafness Treatment (PDT). The secondary aim was to compare hearing preservation between children and adults.

Methods: The data from 274 adults and 100 children implanted with Med-EL M-Array/Standard-Array, EAS/Flex 24;18-20 mm insertion; Standard, Flex 28; 28 mm insertion and Cochlear CI 422 Array were re-evaluated using the HP classification system. The individual hearing preservation results were stratified into 4 categories: Complete, Partial, Minimal hearing preservation and Loss of Hearing.

Results: In children mean volume of preserved hearing (S scale) was 65% and in adults was 55%. The difference in means was not statistically significant. The category of mean preservation is „Partial” in children as well as in adults.

Conclusion: The Hearing Preservation Classification System allows for a larger overview of hearing preservation and should be used as universal standard for reporting. The work was supported by Polish National Science Centre, decision no. DEC-2013/09/B/ST7/04213
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Cochlear Hybrid System: Factors Affecting Outcomes US Clinical Trial Results
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Topic: Other Implantable Devices

Keywords: Future of Implantable Devices, Fully Implantable Devices

Introduction: The Cochlear Hybrid System presents an opportunity for those with precipitous high-frequency (HF) sensorineural hearing loss to improve their speech perception abilities via electrical stimulation of the basal region of the cochlea. Electric stimulation is used in conjunction with low-frequency (LF) acoustic amplification provided by a combined electric-acoustic sound processor. Factors affecting outcomes, as measured via speech perception measures presented in quiet and in noise, will be discussed.

Methods: The 50 subjects were required to have severe HF sensorineural hearing loss (PTA > 70 dB HL 2k-4k Hz) with LF hearing no poorer than 60 dB HL up to and including 500 Hz. Subjects were assessed preoperatively with appropriately fit hearing aids and postoperatively with the Hybrid device at 1m, 3m, 6m and 12m postactivation of the device. Primary outcomes measures were the CNC monosyllabic word test in quiet and AzBio sentences presented at a +5dB SNR.

Results: Mean scores for 49 subjects, who completed the 6 month evaluation, improved from 28%, preoperatively, to 65% for CNC words after 6 months experience with Hybrid for the treated ear alone. For AzBio sentences in noise, mean performance improved from 16% preoperatively to 49% after 6 months experience. Subjects who retained functional LF acoustic hearing postoperatively experienced the most improvement but most subjects benefitted by electrical stimulation alone. Univariable analyses of preop characteristics indicated that gender, age at implantation, and duration of overall hearing loss were the main factors impacting postoperative speech perception outcomes. When subjected to multivariable analyses, duration of hearing loss and gender were related to CNC word outcomes only. Individuals who presented with the poorest outcomes had a mean duration of overall hearing loss of 45 years, while subjects who showed improved outcomes, regardless of retention of LF hearing ipsilaterally presented with a mean duration of around 22 years. Discussion: All subjects who meet candidacy for the Hybrid system have the potential to benefit from electric stimulation regardless of postoperative LF hearing status and should be presented with the opportunity to experience Hybrid hearing.

Conclusion: Electric-acoustic stimulation, as delivered by the Nucleus Hybrid L24 cochlear implant system, is a viable option for individuals with residual LF hearing and severe HF hearing loss. Results showed that a cochlear implant electrode array can be inserted within the cochlea while maintaining useful levels of acoustic LF hearing in most individuals. Even in electric alone conditions, the stimulation provided by the Hybrid cochlear implant yielded superior speech perception capabilities for most subjects when compared with the use of hearing. Age at implantation, duration of high frequency deafness and male gender were significant outcome variables.

Cochlear Americas1, Advanced Bionics2
Hearing Preservation, Hybrid Stimulation, and Speech Understanding in an Expanded Indication Study: Preliminary Results
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Topic: Audiology

Keywords: Residual Hearing, Outcomes

Introduction: Significant advances in cochlear implant (CI) technology and surgical techniques have occurred since the initial approval of the multichannel device almost 20 years ago. Concomitant with these advances has been an improvement in speech understanding and subsequent expansion in indications for usage. Despite these changes, many patients who use hearing aids fall outside of current criteria yet demonstrate great difficulty hearing and communicating in real world situations. These patients usually score too high relative to the candidacy criteria on standard sentence recognition tests (HINT), but score poorly when given monosyllabic word tests (CNC) or more difficult sentence materials (AzBio). They also may have better hearing thresholds than allowed by current criteria. A multicenter clinical study has been initiated to study the effect of CIs in a population of patients who fall outside of current clinical criteria as set forth by the US Food and Drug Administration (FDA). That these patients have more hearing prior to surgery, hearing preservation and electric - acoustic (hybrid) stimulation are additional outcome measures. Objective: The objective of this investigational device exemption (IDE) clinical study is to evaluate the safety and efficacy of a standard length slim straight CI electrode array in a population of newly implanted adults with expanded indications for candidacy

Methods: A prospective, multicenter, repeated-measure, single-arm, open label clinical trial is on-going. Inclusion criteria require moderate hearing loss through 1000 Hz sloping to severe above 3000 Hz in the ear to be implanted, with aided CNC word scores between 10 and 50% for the ear to be implanted; up to 70% contralaterally. Outcome measures include a comparison of pre and post -operative audiometric thresholds, CNC word recognition scores, and AzBio Sentence recognition scores in noise.

Results: A majority of subjects experienced post-operative audiometric threshold shifts of less than 30dB, often resulting in the potential for hybrid stimulation. Early results reveal improvements in CNC and AzBio scores as early as 3 months following the initial activation of their device regardless of sound processor configuration (electric only or hybrid).

Conclusion: Preliminary data indicate that adults with better hearing and speech scores than traditional candidacy criteria can benefit from CI. Moreover, aidable residual hearing can be preserved in many patients allowing for access to hybrid stimulation. These results further support the expansion of current candidacy criteria to include patients with greater degrees of residual hearing. This study was supported by Cochlear Corp.
Cochlear Corporation 1, Advanced Bionics Corp2
Music Perception of Adolescents Using the L24 Hybrid Cochlear Implant

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Introduction: The Hybrid L24 CI is designed for individuals with residual low-frequency hearing sensitivity no poorer than 60 dB HL up to and including 500Hz, severe to profound high frequency sensorineural hearing loss, and who obtain limited benefit from bilateral hearing aids. Because of residual hearing, adult L24 users have superior speech in noise and music perception compared with conventional long electrode (LE) users. Recently, children and adolescents with sufficient low-frequency hearing, stable high-frequency hearing loss of > 90 dB HL at 1500 Hz, and profound loss at higher frequencies enrolled in an FDA trial to evaluate L24 benefit with children. Little is known regarding the efficacy of the L24 with pediatric users, especially for music perception.

Method: Participants were 5 adolescents (11-16 yrs.) with 8-24 months of L24 experience. They were tested on 3 measures of music perception: Complex Pitch Ranking (73-553 Hz); Melodic Error Detection (MED; 131, 262, 523 Hz base frequencies); Melody recognition with auditory and visual cues (MRIL; 261-523 Hz). The cut-off frequency (lowest frequency programmed) ranged from 313 to 1063 Hz. Other variables included age when tested, months of use, cut-off frequency, and device configuration (CI-only or Hybrid (CI + ipsilateral hearing aid)). Participants were tested in a sound treated room at baseline (pre-implant) and 4, 8, 12, 18, 24 months after implantation.

Results: At baseline, complex pitch ranking ranged from 1 to 13 semitones (M = 4.2). The most recent test scores ranged from 1 to 19 semitones (M = 6.2) in the hybrid condition and 1-21 semitones (M=9.6) with CI-only. Marginally significant differences were found on complex pitch ranking between hybrid and CI-only conditions. On the MED (n=4), scores on 131 and 262 Hz were 62.5%, with a decrease to 56.25% on 523 Hz. For the MRIL, identification with visual and lyric cues resulted in perfect scores for all participants. In the melody + rhythm condition, participants scored 84% correct; results were 74% in the isochronous condition (melody without rhythmic cues). Performance on pitch ranking predicted scores on MED and MRIL. The relations among variables differed for the CI-only and hybrid conditions. Length of device use was not a predictor of performance for complex pitch ranking. Cut-off frequency was a significant predictor of performance on pitch ranking for the hybrid and CI only conditions and MED for 262 Hz. Additional relationships between age, pitch discrimination, MRIL and MED will be discussed. Outcomes at 24 months will be compared with pre-implant results and performance by adult hybrid users.

Conclusions: Residual, low-frequency information is advantageous for pitch perception, especially regarding melody recognition and error detection. Additionally, the maintenance of low frequency hearing provides access to information not typically available to traditional implant users for adults and adolescents.
Speech Perception Outcomes And Hearing Preservation Following Cochlear Implantation Of Children With Steeply-Sloping Sensorineural Hearing Loss

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Topic: Audiology

Keywords: Outcomes, Residual Hearing

Introduction: Children with steeply sloping high frequency sensorineural hearing loss lack acoustic access to consonant information that is critical to normal speech and language acquisition. Frequency compression hearing aids are beneficial to some children, but not all. Studies in adults with similar audiometric configurations have shown that combined electroacoustic stimulation is beneficial for understanding speech in quiet and in noise. Therefore, cochlear implantation is considered for children with significant low frequency hearing and severe to profound hearing loss in the critical high frequency regions. This presentation describes the candidacy evaluation process and post-implant outcomes for a series of young children with significant low frequency hearing in the ear to be implanted. Post-implant speech perception outcomes and changes in residual hearing are areas of focus.

Methods: All children met adult criteria for implantation with a combined electroacoustic device with hearing thresholds of better than 60 dB HL at 500 Hz; ≥ 70 dB HL for frequencies ≥ 1500 Hz, and monosyllabic word scores between 10-60% in the ear to be implanted. Pre-implant speech perception testing was completed using age appropriate monosyllabic words presented at an average conversational level of 45 dB HL. Each child had worn binaural hearing aids for at least 6 months. All hearing aids were enabled with a nonlinear frequency compression algorithm and programmed to meet pediatric prescriptive targets. Speech Intelligibility Index results indicated poor audibility for all subjects. Parents underwent a thorough psychosocial evaluation by an experienced psychologist as well as counseling by both the surgeon and audiologist to ensure understanding of the risk of losing acoustic hearing in the ear to be implanted. Surgical technique varied between subjects. Round window insertions were used for 6 ears and a traditional cochleostomy was used for 2 ears.

Results: Pre-implant monosyllabic word speech perception scores ranged from 8-40%. Post-implant scores at 12 months post-implant ranged from 76-84% for monosyllabic tests and 87-92% for sentences tests. Speech Intelligibility Index scores obtained from the best aided condition pre-implant was compared to scores obtained post-implant. All children lost hearing in the implanted ear at 750 Hz and above. Hearing at 250 and 500 Hz showed fluctuations of 5-10 dB up to 6 months post-implant. All children also showed decreases in their unimplanted ears.

Conclusion: Speech perception outcomes indicate significant improvement in speech understanding following cochlear implantation. Hearing preservation results were variable. While these results are encouraging, it is important to have rigorous candidacy evaluations, clear candidacy criteria, and appropriate counseling regarding preservation of hearing when considering cochlear implantation for children with steeply sloping hearing loss.
Perioperative Oral Steroid Use and Low Frequency Hearing Preservation After Cochlear Implantation


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Topic: Surgery/Medical

Keywords: Hearing Preservation, Medical/Surgical Issues

Introduction: Based on previous studies that have shown systemic and topical (transtympanic) corticosteroid use to be therapeutic following cochlear injury, different practice patterns have emerged for perioperative corticosteroid use in cochlear implant recipients. Our study aims to correlate perioperative steroid use with acoustic hearing preservation after implantation.

Methods: Retrospective series from a single surgeon at a tertiary academic referral center. Patients were candidates for a hearing preservation protocol based on their preoperative pure tone thresholds. The tympanic space was bathed in steroids prior to opening the round window membrane in all cases, and all patients were implanted using electrodes designed for atraumatic insertion. One group of patients received a 2-week oral prednisone taper beginning 3 days prior to surgery. The primary outcome measure was the preservation of low frequency pure tone hearing on a 1-month post-operative audiogram.

Results: 22 hearing preservation candidates were implanted during an 18-month period (mean age 50 yrs; range 3-80) ending in December 2013. 13 patients (59.1%, mean age 45.6 yrs) received the oral prednisone taper while 9 (40.9%, mean age 56.3 yrs) did not. There was no significant age difference between the groups (p = 0.18). Within the oral prednisone group, 84.6% of patients had at least a partial hearing preservation (23.1% complete preservation) compared to 33.3% (0% complete preservation) in those not taking prednisone (p < 0.01).

Conclusion: Oral steroids may play a role in low frequency hearing preservation following cochlear implantation. Though the optimal regimen has yet to be identified, a 2 week oral prednisone taper started three days before surgery appears to positively impact the rate of and degree of preservation. Stryker, Synthes, Grace Medical, Cochlear, Advanced Bionics Corp, MED-EL GmbH
The Use of the Cochlear Nucleus® Hybrid™ L24 Device in Adolescents

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Topic: Audiology

Keywords: Outcomes, Residual Hearing

Introduction: The Cochlear Nucleus® Hybrid™ L24 cochlear implant (L24) system allows individuals with steeply sloping hearing loss in the high-frequency (HF) region an alternative to traditional cochlear implantation or hearing aids. The L24 uses electrical signals to stimulate the cochlea, but has a shorter length so that electrical stimulation is presented to the basal area of the cochlea. The overall goal of the L24 is to stimulate the HF region of the cochlea electrically while preserving low-frequency (LF) hearing for continued acoustic stimulation. Research shows that preservation of residual LF hearing significantly enhances listening performance in noise (Turner et al., 2004; Turner et al., 2008a; Gantz et al., 2009); supports perception and sound quality of pitch, melody, and timbre compared to those without residual acoustic hearing (Gfeller et al., 2006); and improves localization abilities (Dunn et al., 2010) through preservation of binaural LF acoustic hearing. Thus far, the L24 has only been investigated in adults and is currently approved for individuals 18 years and older with mild to moderate LF hearing. The purpose of our study is to investigate the usefulness of the L24 in children and adolescents between the ages of 5-15 years with moderate to severe LF hearing loss.

Methods: This FDA-approved investigational device exemption study is being conducted as a repeated-measure, single-subject experiment. Audiologic inclusion criteria include the following: Pure-tone average between 60-90 dB HL from 125 to 1500 Hz; Phonetically Balanced Kindergarten monosyllabic word scores between 0-50% in the ear to be implanted and less than 60% in contralateral ear. Subjects were tested pre- and post-operatively on speech perception using Consonant-Nucleus-Consonant (CNC) words in quiet and Computer-Assisted Speech Perception Assessment test in noise. Spoken language, reading, articulation, and vocabulary measures were also assessed annually to observe progress. Additionally, subjects were evaluated on localization ability. Maintenance of residual hearing was also monitored routinely.

Results: A total of five adolescents with moderate to severe LF sensorineural hearing loss have been implanted with a L24. All subjects continue to utilize an acoustic component and have preserved functional hearing in their implanted ear. Additionally, all wear a contralateral hearing aid. Preliminary results show significant improvements in speech perception scores for combined, bimodal and hybrid conditions compared to pre-operative scores. Speech and language scores indicate continual progress in performance. Further testing and a larger number of data points are needed to make conclusions for localization performance.

Conclusion: The Nucleus® Hybrid™ L24 cochlear implant shows promising results for adolescent children with pre-operative LF residual hearing.

COI: Cochlear And Advanced Bionics1
Session 3: CI in Pediatric Cases of SSD

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Cochlear Implantation for Pediatric Patients with Single-Sided Deafness
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Topic: Audiology
Keywords: Outcomes

Introduction: Cochlear implantation is the standard of care for children with bilateral severe to profound sensorineural hearing loss. More recently, cochlear implantation has been considered a treatment option for patients with single-sided deafness. To date, options for patients with single-sided deafness have included CROS amplification and bone-anchored implantable devices. While these devices may improve speech perception in background noise and localization abilities they do not improve hearing in the affected ear.

Methods: Subjects included 3 children, ages 2, 5 and 9 with unilateral profound sensorineural hearing loss. Two subjects presented with normal to borderline normal hearing in the non-implanted ear and one subject presented with a mild hearing loss sloping to a severe high frequency hearing loss in the non-implanted ear. Etiologies were enlarged vestibular aqueduct with Pendred Syndrome, Connexin 26 and unknown. Two subjects were implanted with the Nucleus device (CI512, Freedom) and one subject was implanted with the Advanced Bionics 90Kj Advantage device. Pre-operative testing was performed using Phonak Naida hearing aids and Phonak CROS system. A plug and muff technique was used when testing the ear to be implanted in order to limit the effects of sound cross over. Post-implant testing was performed using plug and muff technique and direct-connect testing for the Nucleus patient. The main outcome measures included age-appropriate monosyllabic open set word recognition and sentence in noise tests.

Results: All patients had full insertion of the electrode arrays, present NRT/NRI in the OR and no postoperative complications. S1 wears the speech processor all waking hours and S2 wears the processor during school hours but less consistently at home. S1 demonstrated improvement in both word recognition and SRT at the 3-month and 1-year evaluations but has shown decreased performance at the 3-year evaluation with accompanying decrease in thresholds in the non-implanted ear. S2 demonstrated improvements in open-set word and sentence recognition in quiet and noise in the implanted ear at the 3-month evaluation and will, age permitting, be evaluated with the BKB-SIN at the one-year evaluation in order to better assess performance in noise. Subject 3 was recently implanted and the 3-month evaluation is due.

Conclusions: Cochlear implantation can provide improvements in open-set word and sentence recognition unilaterally and binaurally in children with single-sided deafness. Criteria for implantation, programming techniques and therapeutic methods need to be explored for optimal success. Further, the introduction of electrical stimulation in those with a normal or near-normal ear may result in adjustment issues that require counseling, programming modifications and interventions. Hearing sensitivity in the non-implanted ear should be monitored for changes which could affect overall performance.
Introduction: Several studies demonstrated a benefit for adult patients with acquired single sided deafness (SSD) after cochlear implantation (CI). In particular, this was shown for speech understanding in noise and localization abilities. SSD is known to affect educational opportunities in children. Thus, children with SSD have been implanted at our University ENT department since 2011. This case series gives an overview of the current and ongoing studies of SSD children provided with a CI.

Method: Seven children with SSD were implanted at the ENT department of the university hospital. The age at implantation was 3 – 12 years and the listening experience with CI ranged from 3 to 36 month. Speech understanding in noise was evaluated using the disyllabic Wuerzburger children's test with spatially separated signal and noise. The signal was presented from the front, the noise from the side (90°) of the normal hearing ear. Different signal to noise ratios (SNR) were used to estimate the speech reception threshold (SRT). Additionally localization abilities were tested with a semicircular loudspeaker array in the frontal horizontal plane. All tests were conducted in the normal hearing ear alone (NH) and the best aided (NH+CI) listening conditions. A semi structured interview was carried out, to evaluate the subjective benefit from the parental view.

Results: A benefit of 5\% to 35\% was shown for all children, at least for one SNR. In some children only a small or no benefit, and in two cases a worsening of 5\% and 10\% was evaluated at single SNRs. Localization ability was improved for all children in the NH+CI condition. The parents reported about several improvements in behavior since implantation. Discussion: The positive evaluation of the CI by the majority of parents is supported by the audiological data. The results of speech understanding in noise are ambiguous. The stage of development and fatigue after extensive testing, may explain for this.

Conclusion: Cochlear implantation in SSD children clearly improves localization abilities. Moreover, there is a trend of improved performance for hearing in noise in the majority but not all of patients and a positive evaluation by the parents. Thus, the results of CI in SSD children appear to be similar to those of adults, but further evaluation is necessary.
Introduction: Cochlear implants (CIs) are a possible treatment option for alleviating tinnitus in an ear with an accompanying hearing loss. For those with single-sided deafness (SSD) with accompanying tinnitus, implantation of a CI in the affected ear (for tinnitus treatment, or otherwise) yields bimodal, bilateral hearing. The present study investigated the effects of adding the CI, in terms of spatial hearing and listening effort. Results from the first patient, post-operative 18-months [Gartrell et al., Otol Neurotol, 2014] identified specific conditions under which the bimodal listening condition provided a benefit with regard to spatial unmasking of speech from noise. Objective: In the current study, testing was conducted to determine whether the addition of the CI would lead to reductions in listening effort, compared to only having unilateral acoustic hearing. In question was whether the benefit of adding the electric ear would be greater than the potential degradation of sound that is characteristic of CIs. This issue underscores many of the ongoing questions in audiological care with regard to the potential benefits of SSD treatment.

Methods: The task was to hear and verbally repeat simple sentences presented in quiet, and in noise. Participants listened with the acoustic ear alone, the CI ear alone, or in the bimodal condition. In experiment one, the target speech and maskers were varied in location to evaluate spatial unmasking. The second experiment had a similar procedure, except that pupil diameter was measured as an index of listening effort during the recall task.

Results: To date, improvement in speech intelligibility in noise has been found when the target and maskers are spatially separated, compared with when they are co-located, indicating spatial release from masking in the bimodal listening condition. Additionally, subjective reports of tinnitus show marked reduction (improvement) that persists for over 2 years after activation of the CI. Pupillometry results provide objective measurements of changes in listening effort resulting from the use of the implant. Multiple measures of pupil dilation were collected in different listening conditions and will be summarized in this presentation.

Conclusion: In the event of SSD accompanied by tinnitus, the effect of providing a CI has implications for patients not only in terms of tinnitus relief, but also in terms of improved hearing function in everyday listening situations and reduced listening effort. Testing speech in noise, and in particular testing for spatial unmasking can be informative regarding the ability of SSD patients to integrate inputs across the two ears. For cases where speech intelligibility performance with a single healthy ear leaves little to no room for improvement, measures of listening effort will provide a useful objective metric to corroborate anecdotal reports from SSD patients regarding their experience and satisfaction with treatment.
Introduction: There is little doubt about the benefits of binaural hearing. Children are routinely fit with hearing aids for bilateral and unilateral degrees of hearing loss to assist with binaural hearing. Binaural hearing has long been promoted due to its significant benefits which include improved localization, speech in noise performance and binaural integration. Binaural hearing can also be obtained by using a cochlear implant and a contralateral hearing aid (bimodal hearing). Despite our understanding of the benefits of binaural input, the treatment of unilateral profound sensorineural hearing loss (SNHL) has continued to center around techniques that utilize monaural auditory input and exclude these binaural advantages. The customary recommendations at most centers for children with unilateral profound SNHL include observation, FM system, CROS-hearing aid, bone conduction hearing aid and/or the implantation of a osseointegrated bone conduction hearing implant. A recommendation of cochlear implantation to address the actual problem in the non-hearing ear, instead of “borrowing” from the other ear, in most centers is not part of the treatment paradigm. Based on the well documented benefits of binaural hearing, our clinic has begun “off-label” cochlear implantation for pediatric patients with SSD. Objective: Our objective in our cohort is to demonstrate that children with unilateral profound SNHL do not develop binaural interference and receive benefit from cochlear implantation.

Methods: Case study of seven children ranging in age from 2 to 12 years of age with unilateral profound SNHL. Single sided deafness (SSD) was defined as a pure tone average (PTA) in the better ear of less than 30 dB and in the deaf ear as greater than 85 dB. Their pre and postoperative audiometric findings, speech perception findings, and parents’ subjective reports were reviewed.

Results: Seven children with SSD have successfully undergone cochlear implantation. All children have received benefit from their cochlear implants with postoperative PTA hearing thresholds in the implanted ear of less than 30 dB. Objectively, improvements have been obtained in speech perception scores and progress in speech therapy. Subjectively, improvements in quality of life, academics and socialization have been reported by parents.

Conclusion: Children with unilateral profound SNHL receive benefit from cochlear implantation without evidence of binaural interference.
Cochlear Implantation in Single Sided Deaf Children

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Keywords: New Indications, Young and Very Young Children

Introduction: Several treatment options of single sided deafness or asymmetric hearing loss exist depending on: the aetiology of hearing loss, the duration of deafness, the patency of the cochlea and auditory nerve, and economic conditions of the health care system. If no contraindication exists, cochlear implantation (CI) in adults is the treatment of choice in single-sided deaf patients (SSD). So far, only case reports have been presented on the results after CI in children with SSD.

Methods: In a monocenter study, a total of 14 children with severe to profound SSD were examined before and after CI surgery due to SSD. 3 children presented with congenital SSD, 11 suffered from acquired SSD with different durations of deafness. CI was recommended if the preevaluation including MRI ruled out a hypoplasia/aplasia of the cochlear nerve. Speech reception thresholds were examined in 3 different speech in noise presentation conditions S0\text{N}0, S45\text{N} 45 und S 45N45, as well as localisation capability 12 months after first fitting using either children sentence test or Oldenburg sentence test in noise.

Results: The speech reception results preoperatively unaided and 12 months after first CI fitting were compared. After 12 months the majority of the children showed significantly better localization ability and speech understanding in noise compared to the unaided situation. The children with acquired unilateral deafness and short duration of deafness presented with superior results compared to children with long duration of deafness. If the children were capable to perform the audiological test setting of adult SSD patients, results were comparable or even superior compared to the audiological results of our adult SSD patients after CI surgery.

Conclusion: As already demonstrated for adults, children suffering from SSD can profit from CI, too. If medically indicated, CI is the most beneficial hearing rehabilitation in children with SSD. Attention should be paid to the sensitive periods of maturation of the auditory cortex; the best age for implantation will be discussed. Considering our experience, a thorough evaluation and extensive counselling regarding treatment options is necessary. Counseling on all rehabilitation options is important, and alternative options like conventional contralateral routing of signal hearing aids and bone-anchored hearing instruments should be tested to support the decision of the child and the parents. The restoration of bilateral hearing by cochlear implantation improves the quality of life, however, the costs has to be balanced against the costs of this treatment option.
Cochlear Implants and SSD: Initial Findings with Adults, Implications for Children


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Topic: Audiology

Keywords: Binaural Hearing, Outcomes

Introduction: Single sided deafness (SSD), or severely asymmetric hearing loss, disrupts binaural hearing. The negative effects of which are seen in difficulty understanding speech in noise and increased listening effort. Binaural hearing may be partially restored through the use of cochlear implantation. Conversely, a cochlear implant contralateral to a normal or close to normal hearing ear may cause bilateral confusion; a scenario in which performance of the near normal side is degraded by addition of a contralateral CI.

Objective: The aim of this study was to determine if adults and children with SSD or asymmetric hearing loss benefit from use of a cochlear implant.

Methods: To date, nine adult patients and four children with SSD have received cochlear implantation. Test measures include CNC words in quiet, speech understanding in an R-SPACE 8-speaker array, spatial release of masking, and listening effort.

Results: Preliminary results demonstrate significant benefit for speech understanding in quiet and speech understanding in noise. Results of spatial release of masking and listening are ongoing and will be discussed.

Conclusion: Preliminary outcomes demonstrate significant benefit from cochlear implantation for adults and children with SSD or asymmetric hearing loss.
Spatial Acuity and Lateralisation After Cochlear Implant in Unilateral Deafness: Where Does the Auditory Cortex Come In?

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Topic: Audiology

Keywords: Binaural Hearing, Outcomes, Objective Measures

Introduction: Sound localization in the horizontal plane relies on two binaural cues: interaural level difference (ILDs) and interaural time difference (ITDs). The aforementioned cues help to localize high frequency and low frequency sounds respectively. Inability to localize a sound source is one of the major complaints of people with unilateral profound hearing loss. Improvement on localization abilities can be the driving force for these patients to explore the possibility of cochlear implantation.

Objective: This study aimed to observe the localization performance of patients with unilateral deafness who received a cochlear implant (CI).

Methods: Sixteen adults (9 male, 7 female) with postlingual unilateral deafness who opted for a CI after a trial of wireless CROS hearing aids and bone anchored hearing aid (Baha) were included in this study. All subjects received the Med-El (Innsbruck, Austria) CI system and wear the speech processor on a full time basis. The speech processors were programmed with fine structure speech coding strategies (FS4 or FS4-p). Bilateral loudness balancing was performed for each patients’ program settings. Localization testing was performed using the Auditory Speech Sounds Evaluation software (A§E®, PJ Govaerts, Antwerp, Belgium). Each patient performed the localization testing in two listening conditions: monaural hearing (normal acoustic hearing alone) and binaural hearing (acoustic hearing and CI activated). The order of the test was randomised. All patients had at least 6 months experience with their CI.

Results: Analysis of the results showed that the group performed significantly better with CI on when compared with CI off. The majority of patients presented an RMS measure that was similar to those with normal hearing.

Conclusion: Cochlear Implantation for unilateral deafness is able to restore sound localization to levels of normal hearing. Duration of deafness does not impact the outcomes in patients.
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A New Stimulation Mode: The Virtual Tripole
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Topic: Basic Research

Keywords: Sound Processing, Speech Coding, and the Cochlea

Introduction: Spectral resolution limits performance with cochlear implants. Current shaping is used in attempts to improve spectral resolution. Current steering (e.g. virtual channels) is used to increase the number of channels beyond the number of electrodes. Current focusing (e.g. partial tripolar stimulation) is used to reduce interaction, increase independence, and improve spectral resolution. We propose a modification of a traditional tripole called a virtual tripole (VTP). The VTP is designed to reduce spread of excitation as while allowing current steering. Tripolar stimulation consists of stimulation on one electrode combined with simultaneous out-of-phase stimulation on adjacent electrodes to reduce current spread. With a VTP, each of the three electrodes in a tripole is replaced with a virtual channel, theoretically allowing for both current focusing and current steering. The new stimulation mode has the advantage over the previous current steering and current focusing stimulation modes (such as the Quadrupolar Virtual Channel or QPVC) in that the spread of excitation should be approximately symmetrical regardless of virtual location stimulated.

Objective: The objective is to introduce and evaluate the VTP. The VTP has the potential to provide increased places of stimulation (like a traditional virtual channel), reduced spread of excitation (like tripolar stimulation), and a symmetrical distribution (unlike a QPVC).

Methods: Six Advanced Bionics users participated. Spread of excitation was measured for monopolar, partial tripolar (σ = 0.75) and VTP (σ = 0.75 and 1) maskers on electrode 9 using a forward masking technique. The probes were partial tripolar (σ = 0.75) pulse trains on electrodes 6-12. Spread of excitation was also measured for monopolar virtual channels and VTP (σ = 0.75 and 1 when possible) maskers on electrode 8.5. The probes were VTP (σ = 0.75) on electrodes 6.5-10.5.

Results: VTP stimulation provides a reduction in spread of excitation compared to monopolar stimulation. VTP (σ = 1) stimulation provides a narrower spread of excitation than partial VTP (σ = 0.75) stimulation. However, partial tripolar (σ = 0.75) stimulation using physical electrodes seems to produce a narrower spread of excitation than even a full VTP (σ = 1). Effect on spectral resolution was measured using a modified spectral ripple task, the SMRT task (Aronoff and Landsberger, 2013). Subjects tested showed better spectral resolution with a VTP compared to MP stimulation.

Conclusions: VTP stimulation provides a narrower spread of excitation than monopolar stimulation. VTP stimulation provides better spectral resolution in a speech processing strategy using current steering than a traditional current steered virtual channel strategy. Improvements with a current focused virtual channel strategy could be larger with pre-lingually implanted children whose auditory systems developed directly in response to electrical stimulation.

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