CASLPA Position Paper on Cochlear Implants in Children (1995)

Document de prise de position de l'ACOA sur les implants cochléaires chez les enfants (1995)

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Note: A position paper represents the direction CASLPA has taken on a particular topic or provides guidelines for particular areas of practice. These positions are time-bound, representing the thinking at a particular point in time.

Nota: *Un document de principe représente la position de l'ACOA sur un sujet donné ou offre des lignes directrices en ce qui a trait à certains champs de pratique. Ces positions sont ancrées dans le temps et représentent le point de vue de l'Association au cours d'une période donnée.*

Multichannel cochlear implants have become an important option in the management of children with profound bilateral sensorineural hearing loss. In 1990, the U.S. Food and Drug Administration, Public Health Service and the Bureau of Medical Devices, Health and Welfare Canada, approved marketing of the 22-channel Nucleus Cochlear Implant for children aged 2 through 17 years. The multichannel cochlear implant is considered an acceptable option for deaf children by the American Academy of Otolaryngology, Head and Neck Surgery Inc., the Alexander Graham Bell Association for the Deaf, the Network of Educators of Children with Cochlear Implants, the Canadian Hard of Hearing Association, and the Canadian Society of Otolaryngology, Head and Neck Surgery. The National Association of the Deaf (NAD), and the Canadian Association of the Deaf (CAD) however, are opposed to cochlear implants for children. The National Association of the Deaf reports that there is little evidence to support that cochlear implants improve the speech perception abilities of deaf children. Cochlear implants are also seen as an extreme way to make deaf children more similar to hearing children. Audiologists and many professionals working with the hearing impaired see cochlear implants as providing an opportunity for some deaf children to perceive sound and become part of the hearing world. These diverse views make the issue of cochlear implantation of children very complex.

> "An understanding of the cultural, educational and social issues associated with cochlear implantation is essential for counseling prospective patients and their families, as well as fostering appropriate research" (Tyler 1993, p. 26).

In 1993, the Canadian Association of Speech-Language Pathologists and Audiologists (CASLPA), which is dedicated to providing national leadership in the field of human communication and its disorders, assembled a working group to draft a position paper on cochlear implants in children. The following expanded position statement was prepared by the group which included Dawn Delicati (B.C. Children's Hospital), Lynne Brewster (Saskatchewan Preschool Auditory Rehabilitation Centre), Elizabeth Fitzpatrick (Children's Hospital of Eastern Ontario, formerly Central Speech and Hearing Clinic), Agnes Phillips (Montréal Oral School), and Andrée Durieux-Smith (Chair, University of Ottawa).

It is beyond the scope of this paper to provide an exhaustive review of the literature on cochlear implants in children. The CASLPA position paper was developed using some of the key articles published in the literature which document changes in speech and language development, and speech production in children as a result of cochlear implantation. The psycho-social development of implanted children is addressed, although little research has been carried out in this area. Finally, a review of medical and surgical complications and risks with the multichannel cochlear implant is presented.

This paper was developed following an extensive review by professionals working with children with cochlear implants. Thanks are extended to these individuals. Because of the rapid development in cochlear implant technology, this position paper should provide a framework for discussion, but will need to be revised periodically.

Literature Review of Communication Abilities

Since the mid-1980s, cochlear implants have been increasingly used in the management of childhood deafness and implantation has gradually gained wider clinical acceptance.

The use of cochlear implants with children has been controversial (Kessler & Owens, 1989; Miyamoto & Osberger, 1991) and requires long-term study. An array of confounding variables presents researchers with numerous methodological problems which make it difficult to design well-controlled studies. Factors which need to be considered include age, duration of deafness, age at onset of deafness, and the type of educational training program (Berliner, Tonokawa, Dye, & House, 1989; Quittner & Steck, 1991; Sommers, 1991). In addition, research has been difficult because of the small number of users and the difficulty in testing young children.

The studies reported here are drawn from the recent literature on the performance of children with a cochlear implant. The results have been summarized under the headings of pre-verbal behaviour, speech perception, speech production, and language development.

Pre-verbal Behaviour

Tait (1987) analyzed the pre-verbal development of children who had severe and profound hearing impairments and were good and poor hearing-aid users. Good hearing aid users were found to develop a primarily vocal communication style, while poor hearing aid users relied on a primarily visual/gestural style, in the early stages of spoken language acquisition. The pre-verbal development of nine children with pre-verbal deafness, implanted with the Nucleus 22 electrode multichannel system was assessed by Tait and Lutman (1994). Over a 12-month period, children with cochlear implants developed a primarily vocal and auditory style of communicative behaviour similar to the behaviour of proficient hearing aid users, but at a more rapid rate. A longitudinal study of these implanted children is needed to determine if, as with the good hearing aid users, the vocal-auditory pre-verbal measures are predictors of subsequent speech and language development.

Speech Perception

Staller, Dowell, Beiter, and Brimacombe (1991) reported on 142 subjects who had been implanted at 23 investigational centres following a common protocol. The mean age at implantation was 9.2 years (S.D.: 4.6 yrs) and all subjects had worn their implants for at least 12 months. Fifty-three percent of the children were in total communication programs and 33.9% were in auditory-oral educational settings. In summary, all 142 subjects detected sound at conversational levels across the speech frequency spectrum post-operatively, 68% of the subjects demonstrated the perception of spectral information at a segmental level at the 12-month evaluation, increasing to 75% at the 2-year evaluation and to 83% at the 3-year evaluation, although the number of subjects was reduced to 12 at the 3-year evaluation. The results indicate a shift from the perception of pattern only to the perception of segmental cues, a shift which, according to Geers and Moog (1987), suggests the potential for the development of spoken communication in hearing-impaired children. Staller et al. (1991) concluded that the best single predictor of performance in children is age at onset of deafness.

Osberger et al. (1991a) reported on the speech perception abilities of 28 children (aged 2.9-14.0 years) who had used the Nucleus multichannel device for an average of 1.7 years. In this study, 61% of the subjects were classified as demonstrating open-set recognition of words or sentences. In contrast to Staller et al.'s 1991 study, age at onset of deafness and duration of deafness did not impact upon the performance results.

More recently, Waltzman et al. (1994) reported on fourteen congenitally or prelingually profoundly hearing-impaired children who were implanted before the age of 3 years with a mean age at implantation of 2 years, 3 months. All subjects had used the device for at least two years. All 14 subjects demonstrated open-set speech recognition and improvement in the perception of all aspects of speech reception.

Gantz et al. (1994) reported on 54 prelingually deafened children and 5 postlingually deafened children who had used a multichannel cochlear implant between one and five years. Post-lingually deafened children demonstrated significant improvement in their speech perception skills within the first 6-12 months. Results in prelingually deafened children showed a more gradual improvement with some children requiring 2-3 years of implant experience to show significant benefit. After four years of use, 82% of the prelingual group achieved limited open-set understanding. The study suggests that improvement in speech perception skills will continue with prolonged experience.

Speech Production

Tobey and Hasenstab (1991) studied speech production in 78 implanted children aged 2.3-17.7 years using the Ling

Phonetic Level Evaluation (Ling, 1976), and found improved imitative abilities for nonsegmental aspects of speech in the first 6 to 12 months of implant use with a plateau effect observed after this early period. However, the subjects' abilities to imitate segmental aspects of speech seemed to increase with increased auditory experience. Higher speech intelligibility scores were also obtained after one year of implantation on measures contrasting intelligibility before and one year post-implant.

Osberger et al. (1991b) analyzed the spontaneous speech productions of four groups of seven children aged 2.9-14.0 years. The groups consisted of children using the Nucleus 22-channel implant, the 3M-House single channel implant, the Tactaid 11 and hearing aids. The Nucleus 22-channel implant subjects produced more recognizable phonemes in a spontaneous language sample than did children in the other three groups, after one year of use.

Gantz et al. (1994) reported an improvement over a period of five years in vowel, word, and phoneme production scores for pre- and post-lingually deafened children.

Language

There exists very little group performance data on the verbal language abilities of children with cochlear implants. Hasenstab and Tobey (1991) reported on language development with the Nucleus implant in four children who received implants before or at the age of five. Language samples collected pre-implant and at one year post-implant, were analyzed for pragmatic, semantic, syntactic/morphological, and phonological content. The authors concluded that an implant has positive effects for functional spoken interactions for all children regardless of communication mode.

Moog and Geers (1994) estimated language growth by analyzing the spontaneous language samples using a procedure described by Ling as part of the Phonologic Level Evaluation (Ling, 1976). At two years post-implant, 11 of the 12 children produced sentences and 6 of the 12 produced compound or complex sentences. By three years post-implant, 67% (four out of six children) produced complex sentences.

Waltzman et al. (1994) reported on fourteen prelingually deafened children implanted before the age of three years and having two or more years of implant use. All children used oral/aural communication as their primary mode of communication and attended age-appropriate nursery or mainstreamed schools.

Summary

Children with post-lingual profound deafness benefit from multichannel implants in a similar way to post-lingually deafened adults. Some obtain minimal word recognition while others achieve a high level of word recognition and can converse on the phone (Osberger et al., 1991b; Staller et al., 1991). It is clear that most children with post-lingual deafness will benefit from multichannel cochlear implants. Data are now becoming available on children with prelingual deafness (Waltzman et al., 1994; Gantz et al., 1994). Results on these children show a gradual improvement which continues over time. Factors such as age at implantation, experience, and type of habilitation program result in large individual differences in the benefit that children derive from implants. Reliable predictors of performance with a cochlear implant have not been identified and continuing, comparative, longitudinal studies are required to further determine the long-term expectations of cochlear implants in children.

Impact of Cochlear Implants on Psycho-Social Development

The benefits of cochlear implantation in children are becoming better documented in the areas of auditory discrimination, open-set speech recognition, and of speech production. The impact of implantation on the psycho-social functioning of the recipient, however, must also be evaluated.

A cochlear implant has important psychological implications for individuals and usually has a major impact on the lives of recipients and their families. Psychological benefits frequently described by adventitiously deaf adults who have received an implant include decreased feelings of isolation and an increased confidence in social situations (Crary et al., 1982; Wexler et al., 1982; Tyler & Kelsay, 1990).

Knutson et al. (1991) assessed changes in psychological status in adult multichannel cochlear implant recipients with acquired deafness. Their results at 18 months, post-implantation showed a decline in depressed affect, in suspiciousness, in feelings of social isolation, and in loneliness. Their results support the hypothesis that multichannel cochlear implants can result in improved behavioural and emotional functioning in post-lingually deafened adults.

To date no specific research on the impact of cochlear implantation on the psycho-social development of children seems to have been conducted. Psychological evaluations have been used primarily for candidate selection focusing on the cognitive and developmental functioning of the child (Mecklenburg, 1987). Little attention has been paid to the psychological adaptation of the child and family prior to and following implant surgery, yet family support has been identified as a critical factor during these phases (Evans, 1989; Tiber, 1985). Quittner et al. (1991a) assessed the extent of parenting stress and adjustment in parents of children receiving a cochlear implant. The preliminary evidence obtained in this study indicated that cochlear implantation did not reduce levels of parental stress. The results of this study paralleled findings of other investigations indicating that childhood deafness presents ongoing challenges for families (Quittner 1991b).

Research is needed to study outcomes other than the standard audiological and speech and language changes. The impact of variables such as parental expectations, level of motivation, and availability of social support need to be scientifically documented.

In addition, the stresses for the child prior to and following implantation need to be identified. The impact of cochlear implants on the child's functioning in every day situations needs to be evaluated. Anecdotal comments from parents, therapists, and teachers indicate that the implanted child seems "different" post-implantation and more "in tune" with his/her environment. Questionnaires and observational studies of interactions may be appropriate to document the outcome of implantation in the different types of children who receive cochlear implants. This would include post-lingually deafened children, pre- and peri-lingually deaf children in auditory-verbal and total communication programs.

The *Meaningful Auditory Integration Scale* (MAIS) (Robbins et al., 1991) was developed to evaluate the meaningful use of sound in everyday situations by profoundly hearing-impaired children. It provides information on the consistency of device use and on the response to sounds. The behaviours probed by the MAIS indicate benefits that are linked to the meaningful use of the device, not necessarily those related to communication skills alone. The MAIS may be an appropriate tool to evaluate the child's meaningful use of sounds as these occur in everyday situations and may supplement the information obtained from more traditional audiological measures.

Medical and Surgical Complications of the Nucleus 22-Channel Cochlear Implant

The medical and surgical complications of cochlear implantation have been carefully investigated and well documented in a number of centres around the world.

In an extensive survey of Nucleus 22-channel cochlear implant surgeries performed in the United States, Clark and colleagues (1991) and Cohen and Hoffman (1991) noted that the complication rate in 459 adults was 12%, whereas the complication rate in 309 children was 6.8%. These figures include results from 108 surgical teams for adults and 25 surgical teams for children.

The traditional four levels of surgical complications were used: *Mortality, Life-threatening, Major* (requiring surgery or hospitalization), and *Minor* (requiring observation and/or medication). Of the 309 children implanted, there were no deaths or life-threatening complications; 3.9% (12) of the children had major complications, and 2.9% (9) had minor complications. Half of the major complications involved the surgical incision. Half of the minor complications involved facial nerve stimulation. Clark et al. noted that major complications occurred most frequently in children less than seven years of age, with a rate of 7.5% in the 4-6 year old group, and 4.8% in the 2-3 year old group.

Kveton and Balkany (1991) reported a 3.5% rate of significant complications in approximately 500 children implanted with the Nucleus 22-channel device. Significant complications included infection, extrusion, skin flap problems, drainage, electrode displacement, and facial nerve damage. However, they noted that all complications had been successfully resolved except in one patient with unresolved but improved facial nerve paralysis.

Souliere et al. (1994) reported a 6.4% overall complication rate for 534 children under 5 years of age, and a 3.6% rate for 970 children 5-17 years. These rates include complications during surgery, as well as long-term complications such as migration of the electrode array. The most common complication in the younger group of children was malplacement of the electrode array (n=9). The most common complication for the older group was electrode array migration (n=7).

Clark et al. (1991) noted that 75% of all major complications in children could likely have been prevented by modifications in surgical technique. These authors stress the need for adequate training and experience in surgeons attempting cochlear implant surgery. The beneficial effects of surgical experience were also underlined by a study of 153 patients implanted in Hanover, Germany (Webb et al., 1991). In examining the complication rate for these patients, it was noted that whereas the overall rate was acceptably low, the rate for the first 34 patients implanted was double that for the remaining 119 in the group.

Considerable research has been done to determine methods of reducing the risks of cochlear implantation. Much of the recent research has been concerned with biological safety issues related to the implantation of young children (Clark et al., 1991). For example, temporal bone and animal studies have been designed to determine the results of skull growth on the implant, as well as the effects of implantation on skull growth. Modifications of surgical placement of the internal components have been devised to address the concerns about the effects of skull growth on the placement of the receiver/stimulator and electrode array. Conversely, no adverse effects on skull growth were determined in a study of Macaque monkeys with cochlear implants (Clark et al., 1991).

The high incidence of otitis media in the general paediatric population has led to concerns about the possible adverse effects of this disease in implanted children if middle ear infections were to enter the cochlea via the electrode array. However, studies have shown that tissue attachment at the electrode array entry point and development of an electrode sheath may prevent easy access of micro-organisms into the cochlea. The patient is at greatest risk of infection during the first three weeks after surgery, before formation of these tissue barriers is complete. Therefore, preventative measures such as delay of surgery are sometimes required to minimize the risks of infection in a child who is developing an upper respiratory infection. At the time their article was published, Clark et al. (1991) reported no cases of medical complications related to otitis media in their study group of 309 children. Kveton and Balkany (1991) also reported that safety related data on almost 500 children indicated that neither the severity nor the frequency of otitis media was increased in implanted children.

Concerns have also been raised regarding inner ear trauma from cochlear implant surgery as a potential cause of neural degeneration, as well as the possible adverse effects of long-term electrical stimulation. Temporal bone studies reported by Kennedy (1987) documented damage to the spiral ligament within the scala tympani, with more widespread damage to the basilar partition in some cases. However, this study showed that if the electrode is retracted and reinserted upon encountering resistance, damage is minimized. A study by Boggess et al. (1989) assessed the hearing of 40 patients pre- and post-implantation. While they documented loss of residual hearing as measured by pure tone audiometry, the median pre-implant thresholds ranged from 90dB at 250Hz to 115dB at 2000Hz, with no response at 4000Hz. Responses at these levels would generally be considered vibrotactile, and the authors did note that their patients demonstrated no understanding of speech.

Webb et al. (1991) also examined the long-term effects of stimulation in a study using implanted cats. No damage to the spiral ganglion cells was found. There was also no correlation between cochlear calcification and stimulation, as calcification was found equally in stimulated and unstimulated ears. These findings were confirmed in a temporal bone study by Linthicum et al. (1991), who noted no deleterious effects from electrical stimulation on ganglion cell populations. In a small number of the cases they studied, the populations of ganglion cells were, in fact, higher on the implanted side.

In summary, cochlear implantation involves risk, as does any surgical procedure. However, many studies in centres have determined that the complication rate of this surgery is acceptably low. Research continues to find ways to further reduce the risks of this procedure.

Position Statement

Some children with profound deafness do not derive any benefit from hearing aids. The literature indicates that multichannel cochlear implants are of benefit to some deaf children. They are seen as providing improved sound and speech detection and improved auditory perception of speech. Large individual differences exist however, and to date reliable predictors of cochlear implant performance have not been identified.

CASLPA supports the option of multichannel cochlear implants for pre-, peri- and post-lingually deaf children with the following provisos:

- Candidacy should only be considered after comprehensive audiological and medical evaluations of the child, a trial period with adequate amplification in a diagnostic therapy program emphasizing the development of auditory skills, and a complete exploration of parental expectations, compliance, and commitment. In the case of older children and adolescents, a complete exploration of the child's expectations, motivation, compliance, and commitment should also take place.

- Criteria for candidacy should be constantly monitored and re-evaluated as more outcome measures become available and as changes in technology take place.

- Parents have the right to make informed decisions on behalf of and in the best interest of their child and should be completely informed of potential advantages, limitations, risks of cochlear implants, and of alternative educational options for deaf children. Older children have the right to participate in the decision and should be provided with the same information.

- Hearing professionals should understand the position and concerns of the Deaf culture in order to provide adequate counselling to parents, older children, and adolescents on the cultural, educational, and psychosocial issues surrounding cochlear implantation.

- Cochlear implantation should be followed by a comprehensive (re)habilitation program emphasizing the development of listening skills within appropriate communication contexts, and by the ongoing assessment of the child's educational needs.

- Standards or guidelines should be developed for the necessary services to be received by the child with a cochlear implant and his/her family.

- Cochlear implant teams have a responsibility to accumulate data and evaluate the outcome in their populations.

Need for Future Research

Because cochlear implants represent a relatively new option for deaf children:

- There is a need for a database on a national scale and for carefully designed research to study outcome in the areas of communication, speech perception, language and speech production, and of psycho-social development.

- Ongoing research is needed to document the efficacy of different (re)habilitation and educational strategies used with children with cochlear implants.

- Long term follow-up is essential to evaluate the impact of cochlear implants in all aspects of the lives of deaf children and their families.

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