INDEX COPERNICUS INTERNATIONAL

ARTYKUŁ PRZEGLĄDOWY / REVIEW ARTICLE

Management of bilateral implantation in children

Postępowanie terapeutyczne w przypadku bilateralnej implantacji u dzieci

Katarzyna Ita Bieńkowska

The Maria Grzegorzewska University in Warsaw [literally The Maria Grzegorzewska Academy of Special Education] The Society of Parents and Friends of Hearing Impaired Children in Krosno

Article history: Received: 23.02.2016 Accepted: 10.04.2016 Published: 15.06.2016

ABSTRACT: In recent years, the number of children with bilateral implants has been growing. Bilateral implantation, by improving hearing, has beneficial influence on auditory-verbal therapy results. Children with bilateral implants have a chance for acquiring communication skills typical for a given linguistic system and society they live in, at the level similar to natural acquisition. There is an ongoing discussion as to how the therapy of bilaterally-implanted children should be conducted. This article proposes a therapeutic approach based on the current literature and practical experience of the author.

KEYWORDS: auditory verbal therapy, bilateral implantation, cochlear implant

STRESZCZENIE: W ostatnich latach wzrasta w Polsce liczba dzieci zaimplantowanych obustronnie. Bilateralna implantacja – poprzez poprawę słyszenia – wpływa na korzyści z prowadzonej rehabilitacji metodą audytywno-werbalną. Dzieci z obustronnie wszczepionymi implantami mają szansę na podobne do naturalnego opanowanie kompetencji komunikacyjnych typowych dla danego systemu językowego i społeczeństwa, w którym żyją. Obecnie trwa dyskusja nad procedurą przebiegu terapii u dzieci zaimplantowanych obustronnie. Poniższy artykuł stanowi propozycję postępowania terapeutycznego sporządzoną na podstawie dostępnej literatury oraz praktycznych doświadczeń własnych.

SŁOWA KLUCZOWE: terapia słuchu i mowy, implantacja obustronna, implant ślimakowy

INTRODUCTION

A large group of children with a unilateral implant achieve success and acquire a high level of speech development after rehabilitation. [1,32] However, the results are usually studied in a quiet office setting. The number of schoolchildren with hearing impairment in public education is still growing [35], which means that the natural environment, in which an average child over 5 with cochlear implant spends 5-8h a day, is a noisy preschool or school. Ubiquitous noise and excessive visual stimuli significantly hamper hearing, understanding and concentration. [4] Due to limited field and dynamics of unilateral hearing, involuntary hearing is delayed or impossible, i.e. listening, overhearing, finding information in radio or TV, listening to conversations of other people e.g. in the street etc. [8,10], and it constitutes one of the key components of acquisition of linguistic, communicative and cultural skills. [13] In patients with a unilateral implant, compensating behaviors can be observed, such as twisting head towards the source of sound, asking questions, looking at lips and difficulties in: localizing, hearing in noisy surroundings, focusing hearing attention, perceiving music or speech. [14,17] Impediments relating to unilateral hearing influence educational achievements (especially in terms of foreign languages and science). Experiencing stress in noisy environment leads to social alienation, lowered self-esteem and it limits possibility of entering certain professions. [16,18] Some authors suggest that,

depending on accordance between general lateralization and side of implantation, some difficult emotional responses may emerge, including anxiety, breakdowns, nervousness, irritability. [17] It is emphasized that in children with a unilateral implant, it is necessary to use contralateral hearing aid in order to improve therapy results. [2,25,26,33] It is believed that bilateral implants are a chance for stereophonic hearing and they bring objective benefits. [29,11,25] Bilateral implantation in children has become a fact. [23,14] The aim of this article is to describe a proposed therapeutic approach to children with bilateral implants.

FACTORS AFFECTING THERAPY

While setting detailed goals of a therapeutic program aiming at development of hearing skills in a newly-implanted ear, the following factors should be considered [9,20,4]: duration of deafness and its degree in each ear, age, interval between surgical interventions, therapy progress, previous auditory benefits in free field audiometry on both sides, intellectual predispositions, cognitive development, pace of learning, but also additional disabilities, health condition, language proficiency. Other important factors are: course of previous treatment, commitment of family, therapist skills, linguistic environment in which the child is being brought up (sign language, phonetic language and/or various combinations of bilingualism including foreign languages), accessibility of therapy in place of patient's residence, skills and motivation of caregiver.

THERAPEUTIC GOALS AFTER SECOND IMPLANTATION

1. Synchronization of hearing in both implants – synchronizing level of hearing and equalization of comprehension levels.

2. Continuing speech development by hearing – in relation to the level the child presented before the second implantation.

Synchronization of hearing, connected with processor setting and auditory training, lasts 3-24 months on average, depending on the above-mentioned factors (see [20]). However, sometimes it is impossible to achieve satisfactory level of hearing and un-

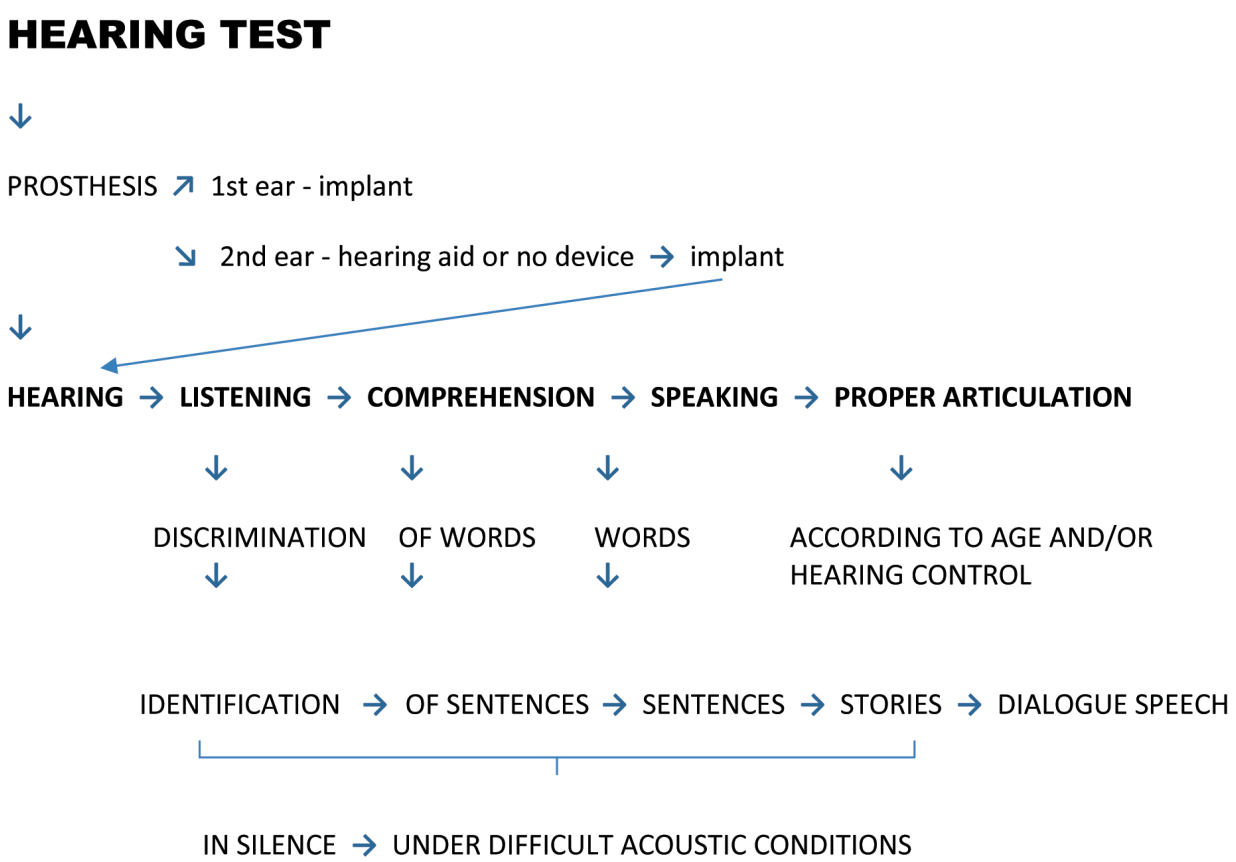

Fig. 1. Algorithm of hearing and speaking training after second implantation

derstanding, despite appropriate training. [23] It is especially common in patients who undergo sequential implantation with time interval of 5 years between the procedures. [11,25] A possible delay in general language development should be considered, particularly following second implantation, as well as even suspension of therapy due to post-operative health condition and/or loss of previous hearing strategy (especially if the child derived benefits from the hearing aid). Both goals should be adjusted to the child's ability level and the skills should be practiced according to the scheme: hearing, listening, comprehension, speaking, proper articulation (see Figure 2).

SEQUENTIAL IMPLANTATION

After placing the second implant, auditory-verbal therapy is continued at the child's level (see Fig.2). However, it is necessary to repeat auditory training according to the classic rules, e.g. [27] on the newly-implanted side. It is advisable to wear both devices all day. Short-term turning off of the first (dominant) device on the other side is recommended (e.g. 15 minutes during speech therapy session and 2 times a day for 15 minutes during home exercises; usually 6-8 weeks until perception is equal on both sides). According to the scheme:

1. Detection (determination of hearing level) – present-absent, speaking-silent, beginning-end of an utterance, perception of new background sounds, perception of sounds in noisy surroundings.

2. Discrimination of instrument sounds, surrounding sounds – awareness of distinctive and various sounds, sound features (amount, volume, dynamics, frequency, pace, type of signal).

3. Discrimination of speech sounds on suprasegmental level – intonation, intensity, emphasis, rhythm – based on sentences, songs, rhymes, sequences of instrument sounds, voice.

4. Discrimination of speech on segmental level - words with different number of syllables, the same number of syllables, similar (e.g. rhyming), in minimal pairs, rhythmic patterns, sentences, voices, discrimination of speech sounds (vowels, consonants, syllables) and words.

5. Identification – connecting sound with its source or meaning in a closed set. Recognizing sounds and words in a series – identification of background sounds, onomatopoeias (CD recordings) and speech – repeating words and phrases (not necessarily with good understanding).

6. Speech discrimination – discriminating speech in an open set, repeating heard phonemes (consonants and vowels), onomatopoeias, words, sentences (e.g. taken from sentence lists), texts.

7. Understanding – words, sentences, orders, long spoken, whispered and recorded utterances, speech from different distances – in a silence, noise, space.

8. Understanding digitally-processed utterances – phone conversation, internet communicators, listening to recordings, e.g. CD, MP3, MP4 etc.

Of high importance is the ability of the therapist to adjust exercises to child's individual needs and abilities, as well as positive approach to exercises.

SIMULTANEOUS IMPLANTATION

After simultaneous implantation of processors and their initial programming, patients should wear both devices all day, also during exercises. Monitoring the functioning and level of each device is crucial in order to prevent discrepancies which may affect future speech comprehension. Previous experiences are significant: auditory memory regarding acoustic features of speech (in case of perilingual hearing loss), benefits of previous aids - hearing level in free field before surgery assessed in both ears (in relation to behavioral MAP, VRA or free field audiometry, depending on patient's age).

Auditory training should be started with initial hearing exercises adapted to the level of devices set according to classic rules (see e.g. [27,9]). With particular focus on narrowing difference field rule (from most different to least different, in order: instrument sounds first, voices with many different features, gradual shift to more difficult combinations of similar sounds). By simultaneous implantation, it is contraindicated to temporarily turn off one processor. The only reason for such conduct is preparation of a well-functioning child, under supervision of the therapist, for transient loss of functioning of one device (e.g. defect) and reading lips. Frequency of sessions depends on child's age and is similar to unilateral implantation [20] (usually 1-2 times a week for 2h in center or home activity).

TRAINING IN NATURAL CONDITIONS

The best method of practicing localizing source of sound, detection, identification of surrounding sounds is to make use of the child's natural environment. Exercises in places other than known closed rooms (home, office, classroom) are particularly

important. The role of the therapist is to show parents how to use natural audio-communicative situations in acoustically difficult places such as e.g. bus, car, playground, forest, church etc. [6,7] Natural environment allows to increase level of difficulty, maintain motivation and concentration - unplanned auditory stimuli demand attention shifting and space localization. Additionally, the emerging noise of the surroundings (wind, street buzz, acoustic background in a supermarket etc.) allows to train bilateral strategies for decoding hearing sensations. Acoustic phenomenon of interfering volumes from both devices (see e.g. [22]) allows to detect and recognize surrounding sounds and speech, which are more quiet than in case of single implant. Thus, it improves perception of speech at natural intensity of 60 - 70 dB. Sample exercises in noise and space:

1. Detection of surrounding sounds - special attention should be paid to sounds that are quiet, as well as previously outside the auditory field - wind blowing, birds singing, clock ticking, water running in pipes or flushing, fan running etc.

2. Intentional visit to noisy places, which have been avoided - in order to train selective auditory attention (noise and background music habituation - learning to ignore background sounds).

3. Responding to new sounds in presence of interfering sounds (introduction of music, noise, playing radio as background for individual or group exercises and everyday conversations).

4. Searching for and localizing source of sound - initially in a small room (practice room, home), then in large space (gym, playing field, hypermarket etc.).

a) in artificial conditions, e.g. auditory training with music playing

b) in natural conditions, in space and difficult acoustic conditions, training while walking, in a bustling street, training in space: on a playground, hallway - searching sound, conversation, comprehension. Repeating words, spoken sentences - in silence and with accompanying backgrounds sounds like playing radio, as well as from a distance: by ear, 1, 3, 5, 10m.

5. In order to show the child the benefits of second implant, it is reasonable to perform VRA training with the first device turned off; the feeling of success motivates older children to practice.

6. Setting on music or radio during everyday play at home.

7. Natural conversation - in 'side-to-side' position as well as 'turning back' - when the child does not see the speaker's face.

STRATEGY IN AN EDUCATIONAL INSTITUTION

In case of a child that is attending preschool or school, the teacher has already some experience with them. Usually, the early development support program and/or special program has already been introduced in the school.

After second implantation, similar to first implantation, the child should be protected from head trauma, it is advised to limit exposure to noise (the child can feel 'lost' for some time due to new quality of hearing and ongoing process of setting devices). Tips for school teachers are not very different from general tips for approaching a child with hearing loss. [5] After 3 months, it is indicated to practice under difficult acoustic conditions (i.e. in normal school conditions in a hallway, club room, gym, playing field etc.). Additionally, it should be remembered to maintain the distance lesser than 3m between the child and the teacher - (even two implants do not make them a fully-hearing person, although they can make them functionally hearing), practicing auditory attention aiming at strategy build-up for stereophonic hearing of speech, e.g. by reading texts aloud to whole group or singing together.

DISCUSSION

There is an ongoing debate between speech therapists, engineers and physician as to when the second operation should take place and how to modify therapy in order to optimize bilateral hearing. The aim of post-implantation rehabilitation is to develop hearing perception of speech [31,19], which is most commonly based on AVT method paradigms. [24] Only few recommendations considering therapy have been published so far [20,21], however, discussions during conferences have been held. [35,36,14,23] The number of documented and published studies on rehabilitated children in Polish is very limited. [14,23] Undoubtedly, this group of patients requires monitoring, not only at qualifying, surgery and processor setting stage, but also during hearing and speech therapy, and introduction of a modified therapeutic program helps optimize the process of learning stereophonic hearing. The concept of short-term turning off of the already trained side is in line with neurobiological rules of topographic excitation of neural network in cortical centers and learning processes. [12] Validity of such approach is confirmed by results of studies on auditory cortex neuroplasticity. [29,25]

SUMMARY

The presented algorithm is a proposal based on personal experience and literature, which should be discussed, concerning

methods of optimization of hearing in case of bilateral implantation. The problem whether training is necessary seems to be out of question. However, further observation of development of this group of patients and dissemination of simultaneous implantation may remove the need for special training. A part of the observed group is characterized by relatively long period between surgical interventions - and hence they required intensified and modified long-term therapy. Other patients, following 10 weeks of training after second speech processor implantation, started to benefit at the level similar to the firstly implanted side.

References

1. Archbold S.: Deaf Education changed by cochlear implantation? Nijmegen: University Nijmegen Medical Centre. 2010.
2. Barker B.A., Tomblin J.B.: Bimodal speech perception in infant hearing aid and cochlear implants users. Arch. Otolaryngol. Head Neck Surg. 2004.
3. Bieńkowska K.: Wpływ wady słuchu na rozwój mowy u dzieci. Problemy Laryngologiczne w Codziennej Praktyce, II/2008, 2–7.
4. Bieńkowska K.(red.).: Od melodii do piosenki – wykorzystanie elementów kultury i przyrody w podnoszeniu poziomu umiejętnosci słuchowych i komunikacyjnych dzieci niesłyszących. Krosno – Preszów. SRiPDzWS. 2012.
5. Bieńkowska K. (red.): Od słowa do rozmowy – wykorzystanie elementów kultury w podnoszeniu umiejętności językowych dzieci z wadą słuchu. Krosno – Preszów. SRiPDzWS. 2013.
6. Crandell C.C, Smaldino J., Flexer C.: Sound field amplification: Applications to acoustics and speech perception. 2004.
7. Estabrooks W.: Auditory – verbal practice. Symposium on the rehabilitation of children with cochlear implants. Niemcy 2000.
8. Flexer C.: Cochlear implants and neuroplasticity: Linking auditory exposure and practice. Cochlear Implants International, 2011; 12: 1.
9. Gordon K., Wong D.E, Papsin B.: Bilateral input protects the cortex from unilaterally-driven reorganization in children who are deaf. Journal of Neurology, 2013; nr 136: 1609–1625.
10. Górska T., Grabowska A., Zagrodzka J.: Mózg a zachowanie. PWN, Warszawa 2005.
11. Grabias S.: Język w zachowaniach społecznych. UMCS, Lublin 1997.
12. Karlik M.,i in.: Obustronne implantacje ślimakowe – doświadczenia własne. Polski Przegląd Otolaryngologiczny. 2013; nr 2: 185–188.
13. Krakowiak K.: Dar języka. KUL, Lublin 2012.
14. Kurkowski M.: Lateralizacja słyszenia a implanty ślimakowe. Audiofonologia. 1996; IX.
15. Kurkowski M: Audiogenne uwarunkowania zburzeń komunikacji. Lublin 2013.
16. Kurkowski Z. M.: Psychopedagogiczne i lingwistyczne konsekwencje głuchot jednostronnych. Audiofonologia. 1999; XV: 209–215.
17. Lachowska M., Niemczyk K., Bieńkowska I.K.: Implanty ślimakowe nowoczesna metoda leczenia głuchoty. Magazyn ORL. 2010; X (3) (39): 75–80.
18. De Raeve L.: Auditory rehabilitation therapy guidelines for optimizing the benefits of binaural hearing. Cochlear; 2008.
19. Ligny C., Simon D., Matogne L., Schepers P.F.: Implantation cochleaire bilaterale pediatrique. *A.N.A.E* . 2015;138: 403–413.
20. Madell J.R., Flexer C.: Pediatric Audiology. Thieme. NY 2008.
21. Mikołajewska L. i wsp.: Ocena percepcji słuchowej u dzieci z obustronnym głębokim niedosłuchem odbiorczym implantowanych obustronnie i jednostronnie. Polski Przegląd Otolaryngologiczny. 2014. 3: 75–79.
22. Pankowska A., Barej A., Lutek A., Zgoda M., Zielińska E.: Metoda audytywno-werbalna w rehabilitacji słuchu i mowy dzieci z wadą słuchu – historia, zasady i praktyka. Nowa Audiofonologia. 2013; 2 (4): 22–27.
23. Papsin B.C., Gordon K.A.: Bilateral cochlear implants should be the standard for children with bilateral sensorineural deafness. Curr. Opin. Otolaryngol. Head Neck Surg. 2008; 16: 69–74.
24. Rosier H.: Wychowanie słuchowe. IFiPS. Warszawa1997.
25. Sharmaa A. et al.: Simultaneous versus sequential bilateral implantation in young children: Effects on central auditory system development and plasticity. Audiological Medicine, 2007; 5 (4).
26. Stadnicka J.: Terapia dzieci muzyką, ruchem i mową. Wydawnictwa Szkolne i Pedagogiczne. Warszawa 1998.
27. Szkiełkowska A., Skarżyński H., Piotrowska A., Lorens A., Szuchnik J.: Postępowanie u dzieci ze wszczepami ślimakowymi. Otorynolaryngologia. 2008;7 (3): 121–128.
28. Szuchnik J.: Badanie rozwoju percepcji słuchowej u pacjentów z całkowitą głuchotą leczonych przy pomocy wszczepów ślimakowych. AM. Warszawa 2000.
29. Woźniak A., Bieńkowska I.K, Niemczyk K., Mikołajewska L., Łukaszewicz L.: Wyniki percepcji słuchowej u dzieci z implantami ślimakowymi: porównanie bimodalnej i elektrycznej stymulacji. Audiofonologia. 2005; 28: 63–66.
30. Zaborniak-Sobczak M.: Polskie rozwiązania systemowe w kształceniu dzieci i młodzieży z wadą słuchu. [W:] Wybrane problemy wsparcia wczesnorozwojowego i edukacji dzieci i młodzieży z wadą słuchu na przykładzie pięciu krajów europejskich. Uniwersytet Rzeszowski. Rzeszów 2016.

Konferencje

31. Wrocław, 20–21.11.2013 – Forum implantów ślimakowych. Katedra i Klinika Otolaryngologii WUM. Cochlear. Medicus.
32. Kajetany, 27.11.2015 – VI Konferencja Naukowo-Szkoleniowa – Słucham, więc potrafię: Po co nam dwoje uszu? O aspektach słyszenia dwuusznego. Instytut Fizjologii i Patologii Słuchu oraz Komitet Nauk Klinicznych PAN.

Word count: 2250 Tables: – Figures: 1 References: 32

Access the article online: DOI: 10.5604/20845308.1202371 Full-text PDF: www.otorhinolaryngologypl.com/fulltxt.php?ICID=1202371

Corresponding author: Katarzyna Ita Bieńkowska; Akademia Pedagogiki Specjalnej im. M. Grzegorzewskiej w Warszawie; e-mail: bienkowska0@op.pl

Competing interests: The authors declare that they have no competing interests.

Cite this article as: Bieńkowska K.I.: Management of bilateral implantation in children; Pol Otorhino Rev 2016; 5(2): 57-62