Research Report

Cochlear implant programme report in Dr. Soetomo Hospital Surabaya

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ABSTRACT

Background: Cochlear implant is a result of technology development which has a great contribution to bilateral sensorineural hearing loss patients when conventional hearing aid does not help or does not give enough benefit for these patients. In Surabaya, this program was started in November 2008. **Purpose:** To report cochlear implant programme in Dr. Soetomo Hospital Surabaya between November 2008 and October 2013. **Methods:** A descriptive retrospective study on complete data from medical record in Dr. Soetomo Hospital Surabaya between November 2008 and October 2013 were evaluated. Forty seven patients received cochlear implant, 3 patients did not have complete medical record and excluded, 44 data were reviewed. **Results:** Forty four patients were implanted, the average of age identification was 22.9 months old, the average of age of amplification was 29.7 months old and the average of age of implantation was 49.0 months old. All of the patients were prelingually deaf. Twenty seven patiens could be evaluated for habilitation with Categories of Auditory Performance (CAP) and the result of receptive, language, expressive and communication abilites were in good progress. **Conclusion:** The sooner the device implanted the better, and evaluation with CAP was effective.

Keywords : Hearing impairment, cochlear implant, habilitation

ABSTRAK

Latar belakang: *Implan koklea adalah hasil suatu perkembangan teknologi yang mempunyai kontribusi besar untuk pasien gangguan pendengaran sensorineural yang tidak bisa dibantu oleh alat bantu dengar. Di Surabaya, program ini dimulai pada November 2008.* ***Tujuan:*** *Evaluasi hasil program implan koklea di RSUD Dr. Soetomo Surabaya sejak November 2008 sampai dengan Oktober 2013.* ***Metode:*** *Penelitian deskriptif retrospektif dan data diambil dari rekam medik yang lengkap di poli Audiologi RSUD Dr. Soetomo selama periode November 2008 sampai dengan Oktober 2013. Dari 47 pasien yang dioperasi, 3 rekam medik tidak lengkap dan dieksklusi, 44 pasien yang mempunyai rekam medik lengkap dievaluasi.* ***Hasil:*** *Empat puluh empat pasien yang dilakukan implan koklea, rerata umur identifikasi 22,9 bulan, rerata umur amplifikasi 29,7 bulan, dan rerata umur operasi 49,0 bulan. Semua pasien adalah tuli sensorineural pre-lingual. Sebanyak 27 pasien dapat dilakukan evaluasi habilitasi dengan Categories of Auditory Performance (CAP) dengan hasil receptive, bahasa, ekspresif dan kemampuan berkomunikasi baik.* ***Kesimpulan:*** *Semakin muda umur pasien saat operasi hasilnya semakin baik, dan evaluasi dengan CAP sangat efektif.*

Kata kunci: *Gangguan pendengaran, implan koklea, habilitasi*

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INTRODUCTION

South East Asia has the largest number of hearing impaired patients in the world. World Health Organization estimates that every year about 38,000 deaf children are born in the region (around 2-4:1000 childbirth). Survey for Hearing Health (1994-1996) in Indonesia, there was congenital deafness 0.1% (222,600). In Dr. Soetomo Hospital Surabaya, between 2008–2012, there were 675 hearing impairment patients below 5 years old and 603 pasien (89.34%) with severe-profound hearing loss.[1] The Joint Committee on Infant Hearing (JCIH) endorses early detection of and intervention for infants with hearing loss. The goal of early hearing detection and intervention (EHDI) is to maximize linguistic competence and literacy development for children who are deaf or hard of hearing. Without appropriate opportunities to learn language, these children will fall behind their hearing peers in communication, cognition, reading, and social-emotional development. Such delays may result in lower educational and employment levels in adulthood.[2] To maximize the outcome for infants who are deaf or hard of hearing, the hearing of all infants should be screened at no later than 1 month of age. Those who do not pass screening should have a comprehensive audiological evaluation at no later than 3 months of age. Infants with confirmed hearing loss should receive appropriate intervention at no later than 6 months of age from health care and education professionals with expertise in hearing loss and deafness in infants and young children. The challenge of early identification, diagnosis, and habilitation of hearing loss in children is critical.[2]

A cochlear implant (CI) is a surgically implanted electronic device that provides a sense of sound to a person who is profoundly deaf (>90 dB) or severely hard of hearing (between 70 and 90 dB). Cochlear implants were first developed in France in 1957 by Djourno and Eyries who described how to stimulate the cochlear nerve by electric currents. The recipients were implanted with a single channel device. This device failed after a short time and another device was implanted. In 1972 House Ear Institute (USA) developed the first FDA approved single channel cochlear implant. In 1978 Clark (Australia) implanted the first multi-channel electrode array. As of December 2010, approximately 219.000 people worldwide have received cochlear implants.[3,4] A cochlear implant is a surgically implanted electronic device that can help provide a sense of sound to a person who is profoundly deaf or severely hard of hearing. The cochlear implant does not amplify sounds like a regular hearing aid however, it by passes the damaged part of the inner ear, replacing it with electrodes, allowing the profoundly deaf individual access to sound. Cochlear implant technology is designed for adults and children over 12 months of age with severe to profound sensorineural hearing loss. Implant candidates must undergo a hearing aid trial to evaluate their benefit from hearing aids, as well as psychological assessments to assure that the parent or user's expectations are reasonable.[3,4]

In Surabaya, cochlear implant programme was started in November 2008. During 5 years programme (November 2008 and October 2013) there were forty seven patients were implanted, 3 patients did not have completed medical record and excluded, 44 data were reviewed. Twenty seven patiens could be evaluated for habilitation with Categories of Auditory Performance (CAP) and the result of receptive, language, expressive and communication abilites were in good progress. Seventeen patients live in another island and could not come routinely. This paper will evaluated the result of cochlear implant programe in Dr. Soetomo Hospital Surabaya.

METHODS

The number of patients between November 2008-October 2013 were 47 patients with 52 ears (4 patients simultaneous bilateral and 1 patient sequential bilateral) who received cochlear implant, 3 patients did not have completed medical record and excluded, 44 data were reviewed. A descriptive retrospective data were reported. All of the data in medical record were arranged in table, divided into age of identification, age of amplification, duration of amplification, age of implantation, cochlear age and evaluation after habilitation.

RESULTS

Fourty four patients' data were reviewed. Twenty seven patients could be evaluated with Categories of Auditory Performance (CAP) result because the other 17 patients lived in another island and could not come routinely, performed Audio Verbal Therapy (AVT) in another city or performed AVT by other therapies.

The degree of hearing loss, 38 patients (86.4%) were profound bilateral sensorineural hearing loss (SNHL), 1 patient (2.3%) was severe bilateral SNHL, 3 patients (6.8%) were profound + moderate SNHL and 2 patients (4.5%) were profound + severe SNHL

The mean of age of identification was 22,9 months. The greatest number was in 12-24 months-age group, 22 patients (50%), followed by 24-36 months-age group 9 patients (20.5%), <12 months 8 patients (18.1%), >48 months 4 patients (9.1%), and the smallest number was between 36-48 months 1 patient (2.3%).

The mean of age initial amplification was 29.7 months. The greatest number was in 12 -24 months-age group, 21 patients (47.7%), followed by 24-36 months-age group 11 patients (25%), <12 bulan and >48 months 5 patients (11.4%) and the smallest number was between 36–48 months age, 2 patients (4.5%).

The mean of age duration of amplification was 19.4 months. The greatest number was <12 months, 18 patients (40.9%), then 12-24 months age group 17 patients (38.6%), 24-36 months age group 5 patients (11.4%), >48 months 3 patients (6.8%) and the smallest number was 36-48 months age group, 1 patient (2.3%).

Table 1. Result of cochlear implant programme

	Number	Percentage
Age of identification (months)		
<12	8	18.1
12 – 24	22	50
24 – 36	9	20.5
36 – 48	1	2.3
>48	4	9.1
Age of amplification (months)		
<12	5	11.4
12 – 24	21	47.7
24 – 36	11	25
36 – 48	2	4.5
>48	5	11.4
Duration of amplification (months)		
<12	18	40.9
12 – 24	17	38.6
24 – 36	5	11.4
36 – 48	1	2.3
>48	3	6.8
Age of implantation (months)		
<12	2	4.5
12 – 24	4	9.1
24 – 36	14	31.8
36 – 48	9	20.5
>48	15	34.1
Cochlear age (months)		
<12	20	43.2
12 – 24	6	15.9
24 – 36	12	27.3
36 - 47	6	13.6
Total	44	100

The mean of age implantation was 49.0 months. The greatest number was >48 months 15 patients (34.1%), then 24-36 months age group 14 patients (31.8%), 36-48 months age group 9 patients (20.5%), 12-24 months age group 4 patients (9.1%) and the smallest number was <12 months 2 patients (4.5%).

The greatest number of cochlear age (begins when the implant is activated and the patients could hear) was <12 months, 20 patients (43.2%), followed by 24-36 months age group 12 patients (27.3%), >36 months and 12–24 months age group 6 patients (15.9%).

Table 2 shows categories of Auditory Performance evaluation. One patient could reach CAP 7 in 5 months because of moderate SNHL in the other side ear and hearing aid give enough benefit for this ear. Three patients can reach CAP 7 in 12 months, 5 patients could reach CAP 7 in 12-24 months and 1 patients reached CAP 7 in 40 months after switch on.

DISCUSSION

Fourty four patients were evaluated, 38 patients (86.4%) with bilateral profound SNHL, 1 patient (2.3%) with bilateral severe SNHL, 3 patients (6.8%) with profound and moderate SNHL and 2 patients (4.5%) with severe and profound SNHL. Referral criteria for children to get cochlear implant is bilateral severe to profound sensorineural hearing loss and limited or no useful benefit from hearing aid.[4] All of the patients in Surabaya had indication to use cochlear implant.

Four patients were performed simultaneous bilateral, 1 patient with sequential bilateral cochlear implantation and the others used bimodal cochlear implantation and hearing aid. The interval implantation in this sequential CI was 9 months. The study in 2008 found, both the interval between onset of deafness and cochlear implantation and the interval between implantation of the first and second ears should be short time in children. The study recommended that simultaneous bilateral implantation be provided when possible and, if not, the inter-stage interval should be limited. The clearest indication that bilateral input provides an advantage in such children is evidence that they are able to discriminate the locations of two sound sources better with both than either one of their implants.[5]

The data showed their mean age of identification was 22,9 months (range between 1–64 months). This indicated a late diagnosis. When a child is born deaf and loses all hearing before 4 years of age, the child will forget all speech and memory.[6] The children whose hearing losses were identified by 6 months of age demonstrated significantly better language than children identified after 6 months of age.[2] The Joint Committee on Infant Hearing (JCIH) recommended that early detection of and intervention all infants should be screened at 1 month, diagnostic 3 months and intervention 6 months of age,[2] the average of age identification patients in Surabaya was 22.9 months. It was very late. A private non profit auditory-verbal centre based program reported the mean of identification was 17 months (range between 0–37 months) for a total 40 children.[7]

Table 2. Categories of auditory performance evaluation

CA \ CAP	1	2	3	4	5	6	7	Number
< 5 months	-	6	4	1	2	-	1	14
5-12 months	-	-	1	-	-	2	3	6
12-24 months	-	-	-	-	-	-	5	5
24-36 months	-	-	-	-	-	1	1	2

The mean of age amplification with hearing aid was 29,7 months (range between 3-150 months). It showed a very late intervention. Joint Committee on Infant Hearing recommended that infants with hearing loss should be fitted with hearing aids by six months old at the latest. The infants' brain is plastic and can learn new things but as he got older the plasticity is lost. This means that teenagers or adults who were born deaf can only get limited benefit from cochlear implant. Not only does the plastic infant's brain has an ability to learn speech but also has the ability to forget speech. If the is child is born deaf and loses all hearing before 4 years of age, the child will forget all speech and memory.[6] In Surabaya there were five patients amplified over 48 months.

The study in 2001 reported the mean age of initial amplification was 20 months (range between 3-40 months). The 40 children were divided into 3 groups, using only hearing aids (HA group), only cochlear implants (CI group), and transition from hearing aids to cochlear implants (HA-CI group) during the course of this investigation. For the HA group, the mean age of initial amplification was 24 months, with an unaided better ear pure tone average of 75 dB HL and an aided better ear pure-tone average of 30 dB HL. For the CI group, the mean age of initial amplification was 18 months and all of them reportedly had either severe-profound or profound unaided hearing loss with a mean aided better ear pure-tone average of 78 dB HL. The average age of initial implant stimulation for the CI group was 43 months. For the HA-CI group, the mean age of initial amplification was 17 months. Again all of them reportedly had severe-profound or profound unaided hearing loss. For this group, a mean aided better ear pure-tone average of 48 dB HL was attained with the mean age of initial implant stimulation at 46 months old.[7]

The mean age of duration of amplification before implantation was at 19.4 months (range of 2–80 months). Hearing aid was the first option and cochlear implant second. Person with a profound hearing loss most likely will benefit more from cochlear implant than from hearing aid. He should try hearing aid first. It is a good practice to run a hearing aid trial before cochlear implantation. The patient will be evaluated with hearing aid for 2–3 months before implantation. In 44 patients, they developed sound, awareness but no receptive and expressive spoken language skills.

Infants or toddlers who cannot benefit from traditional amplification are recommended to use cochlear implant. Children who grow up using cochlear implants have the potential to develop superior spoken language skills. Cochlear implant provides a child with a good chance to develop normal speech and language. The purpose of hearing aids, cochlear implants, personal-worn FM, classroom FM systems, and auditory-based intervention is to access, grow and develop auditory brain centers.[8]

The mean age of implantation in our study was 49.0 months. This showed a late intervention compared with other studies. Yoshinaga-Itano et al,[2] at 1998 compared receptive and expresive language abilities of earlier and later identified deaf and heard of hearing children. The result showed that better language development was significantly associated with early identification of hearing loss and early intervention. There was no significant difference between the earlier and later identified groups on several variables frequently associated with language ability in deaf and hard of hearing children. The critical period for identifying and intervention is at 6 months age of life.[9,10]

The study in Melbourne on 106 children showed the results demonstrated that cochlear implantation may be performed safely in very young children with excellent language outcomes. The mean rates of receptive and expressive language growth for children receiving implants before the age of 12

months were significantly greater than the rates achieved by children receiving implants between 12 and 24 months, and matched growth rates achieved by normally hearing peers.[11] The study in USA in 38 children received their implant between 12 months and 23 months of age, and 45 children received their implant between the ages of 24 and 36 months. This study demonstrated that children who received a cochlear implant below the age of 2 years obtain higher mean receptive and expressive language scores than children implanted over the age of 2 years.[12]

Another study reported that on average, children who received a cochlear implant before 12 months of age developed auditory comprehension and expressive communication similar to their normal-hearing peers. These results support the importance of early implantation. The evidence implies that when infants confirmed hearing loss exceeds 90 dB HL, implantation before 12 months of age would lead to rapid language gains.[13] This is consistent with another report showing changes in neural response within central auditory pathways of two children shortly after cochlear implantation at ages 13 and 14 months and the changes appeared to be related to development of early communicative behaviours.[14] This study has also found that early hearing aid fitting was associated with normal language development. Early use of hearing aids provides auditory stimulation that is vital for development of the auditory system and access to language. The cochlear implant should form a routine part of the discussion about devices for families of children who have a severe to profound hearing loss. Fit hearing aids to all children with residual hearing as soon as possible after the family have agreed to proceed with the fitting.[13]

In Surabaya, the amplification rate was at 29.7 months and the intervention with cochlear implant was at 49.0 months, which means it was very late. Rhoades[7] report, the mean age of initial amplification was 18 months and all of them reportedly had either severe-profound or profound unaided hearing loss with a mean aided better ear pure-tone average of 78 dB HL. The average age of initial implant stimulation was 43 months.

The greatest neuroplasticity is in the first 3½ years of life, the younger the infant, the greater the neuroplasticity. Rapid infant brain growth requires prompt intervention, typically including amplification or cochlear implants, and a program to promote auditory skill development. Data suggest that children receiving implants very early (around 1 year of age) may benefit from relatively greater plasticity of the auditory pathways than children with implantation later within the developmentally sensitive period. Data suggest that the development of early communication behaviors following implantation may be promoted by changes in central auditory pathways. Emerging data are showing that over 90% of children born with a profound hearing loss who obtain a cochlear implant before they are 2, attain intelligible speech.[15] That's why early identification and implantation before age 2 is critical. Early identification and technological management is essential to take advantage of brain neuroplasticity.[16] Two factors strongly influence the brain response to deafness and implantation, first whether deafness occurs before or after oral language acquisition, and second how much time has elapsed between the onset of deafness and cochlear implantation, i.e. the duration of sensory deprivation.[16]

Chronological age begins at birth and cochlear age begins when the implant is activated. Cochlear age is used as a tool for evaluation by Auditory Verbal Therapy for speech and language expectations/ development based on cochlear age. Categories of Auditory Performance (CAP) is used to assess the overall benefit of a cochlear implant to each child. Parents and/or teachers

are asked to rate performance across eight categories (CAP 1) with 7 categories, 0: No awareness of environmental sounds or voice, 1: Awareness of environmental sounds, 2: Response to speech sounds, 3: Identification of environmental sounds, 4: Discrimintion of speech sounds without lipreading, 5: Understanding of common phrases without lipreading, 6: Understanding of conversation without lipreading, 7: Use telephone with known speaker.[17]

In this study, only 27 patients could be evaluated for the Categories of Auditory Performance (CAP) because 17 patients live in another island and could not come routinely, they performed Audio Verbal Therapy (AVT) in another city or performed AVT by other therapies. One patient could reach CAP 7 in 5 months because of moderate SNHL in the other side ear. Three patients could reach CAP 7 in 12 months, 5 patients could reach CAP 7 in 12-24 months and 1 patients reached CAP 7 in 40 months after switch on.

Archbold[18] reported in 53 children, assessed for CAP before and after implantation. Before implantation only 2 of the children showed CAP 1, immediately after initial tuning all children showed CAP 1, and 50% showed CAP 2. Their auditory receptive abilities gradually developed over 3 years period. They predicted that 90% children will understand conversation without lipreading 5 years after initial tuning (CAP 6).

Another study at Speech and Hearing clinic Ramathibodi Hospital reported that CAP score was found to be a useful an sensitive tool to evaluate the outcome of auditory receptive and expresive abilities in young congenitally deaf children who underwent cochlear implantation.[19] Bakhshaee et al[20] conducted a study to determine the auditory performance of congenitally deaf children and the effect of cochlear implantation on speech intelligibility by using the categories of auditory performance (CAP). A total number of 47 children were prelingually deaf and were younger than 8 years of age. They were followed up until 5 years after implantation. The results were the children showed significant improvement in auditory performance after implantation. Six months after implantation 91% of children had the ability to respond to speech sounds. At the end of year one, 96% of children could discriminate speech sounds and 84% of children who reached the three years interval could understand common phrases without lip-reading.

Our study found that the earlier cochlear implants, seemed to show the better results. A younger age at implantation was also associated with optimum communication outcomes for children with cochlear implants. Categories of Auditory Performance had been found to have good inter-rate reliability. The rating scale could be used in different languages with confidence. Categories of Auditory Performance could be effectively used to monitor the auditory progress of children following cochlear implantation. Analysis for significancy should be further evaluated.

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