Initial outcomes of the cochlear implant surgery at 108 Military Central Hospital

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Summary

Objective: To assess the initial outcomes of cochlear implant (CI) surgery and the auditory recovery of the patients underwent CI surgery at the Ear-Nose-Throat Department, 108 Military Central Hospital from January 2016 to June 2020. *Subject and method:* Twenty-two CI recipients were included in this study. *Result:* 50% of the included subjects was younger than six years old, had prelingual and severe to profound hearing loss bilaterally. No severe complications was observed except the two cases with minor ones. Postoperatively, 80 - 90% of the subjects was able to recognize and discriminate the environmental sounds and the six ling sounds. Postoperative free field tests gained to normal or mild hearing loss. *Conclusion:* CI surgery is an effective approach for managing cases with severe to profound hearing loss.

Keywords: Cochlear implant, ENT Department, 108 Military Central Hospital.

1. Background

In a cochlear implantation surgery, a neuroprosthetic device is inserted into the cochlear of a person with moderate to profound sensorineural hearing loss. This implanted device then creates electric signals to stimulate the auditory nerve so that the person can hear sounds again. Cochlear implantation were popularly implemented in many developed countries 30 years ago, and has been done in Vietnam since 1998.

Cochlear implant is proved to be an optimal choice for severe to profound hearing loss patients in a vast number of studies. In 2016, the first cochlear implantation surgery was performed at the ENT Department of 108 Military Central Hospital. Since then, many patients have been implanted. This study was conducted to assess the main characteristics of the cochlear implant receivers and their recovery of hearing function postoperatively.

2. Subject and method

2.1. Subject

Time scale: From January 2016 to June 2020.

Including criteria

Bilateral sensorineural hearing loss greater than 70dB, absence of the benefits of hearing aids.

No abnormalities on the implanted ears structure (CT-scan and MRI).

Normal auditory nerve function.

No psychological disorders.

Strong motivation and realistic expectations for improving hearing.

No contra-indications for general anesthesia.

Fully recorded medical documents with relevant information preoperatively and postoperatively.

2.2. Method

Study design: Descriptive with clinical intervention.

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Study process

Step 1: Several variables (as in 2.5) were collected preoperatively.

Step 2: Cochlear devices were implanted for these patients unilaterally or bilaterally based on the financial state of their family and their aspirations.

Step 3: The devices were activated one month after the surgery. Similar variables to preoperative ones were collected at the time of activation (one month), six months and twelve months.

Studied variables

Pure tone hearing thresholds (in dB HL) of the implanted ears were collected by doing the Pure Tone audiometry test at the frequencies of 250, 500, 1000, 2000, 4000 and 8000Hz through bone and air conduction. PTA (Pure tone average) was then calculated by the sum of air conduction hearing threshold at 500Hz, 1000HZ, and 2000Hz then divided by three.

Free field hearing thresholds of the implanted ears were obtained by having the patients (with their cochlear implants activated and hearing aids on the opposite side on) listened to pure tone sounds through amplifiers placed in a silent room. The smallest tone that the patients able to hear were his/her thresholds.

The Six Ling sounds Test: This is a basic audiological test used six lingual sounds including [m], [ah], [oo], [ee], [sh] and [s] at various distances to evaluates how well patients were hearing. These sounds are chosen because they approximately cover sounds ranging from 250 - 4000Hz and represent speech in the low, mid, and high frequencies. In this test, the cochlear implant receivers were asked if they could discriminate and repeat "the Six Ling sounds" at a distance of thirty centimeters, one-two meters and over two meters. The softest sounds that the patient could hear were their thresholds to recognise the sound and the softest sounds that he/she could hear and repeat it correctly were the thresholds of discrimination.

The environment sound test: Subjects were ask to tell if they could recognize and discriminate background sounds such as a sound of a drum, doorbell or a running water tap etc at a distance of thirty centimeters, one-two meters and over two meters. The softest sounds that the patient could hear were their thresholds to recognise the sound and the softest sounds that he/she could hear and tell it correctly were the thresholds of discrimination.

2.3. Data analysis

Data were gathered into the Microsoft excel 2013.

Categorical variables were calculated their frequency and percentage.

Analytical tests were performed by SPSS 16.0 software.

3. Results

3.1. Subjects' characteristics

Among twenty-two selected patients, only one case had implanted bilaterally.

Table 1. Subjects' characteristics

Variables	Frequency	Percentage	p
Sex (n = 22)			
Male	10	45.5	>0.05
Female	12	54.5	
Age group (n = 22)			
≤ 3 years	7	31.8	>0.05
4 - 6 years	4	18.2	
7 - 18 years	3	13.6	
≥ 18 years	8	36.4	
Variables	Frequency	Percentage	
Types of deafness (n = 22)			
Prelingual	15	68.2	p<0.05
Postlingual	6	27.3	
Progressive	1	4.5	
Implanted ears (n = 23)			
Left ears	6	26.1	p<0.05
Right ears	17	73.9	
Preoperative PTA (n = 23)			
70 - 90dB	3	13.04	
91 - 100	2	8.7	

101 - 110	8	34.78	
> 110	10	43.48	p>0.05

There was no differences between subjects regarding their age and sex (p>0.05). Half of subjects (11/22) was at preschool ages. Most of them had prelingual hearing loss (68.2%) and was implanted on the right ears (73.9%).

Table 2. Postoperative complications (n = 23 ears)

Complications	Frequency	Percentage
Facial paralysis	1	4.35
Infections	0	0
Meningitis	0	0
Tympanic membrane perforation	1	4.35
Cerebrospinal fluid leakage	0	0

There were only two minor complications including facial paralysis and tympanic membrane perforation.

3.2. Hearing recovery

3.2.1. Hearing environmental sounds

Table 3. Abilities to recognize environment sounds pre vs postoperatively (n = 22)

Ability / Time	Unable	Able at 30cm	Able at 1 - 2m	Able at > 2m	Sum
Preoperative	8	11	0	3	22
1 month postop	0	8	7	7	22
6 months postop	0	0	12	10	22
1 year postop	0	0	4	18	22

Preoperatively, all patients were unable to recognise or only hear the sound at a short distance. Six months postop, all these patients have gained their ability considerably.

Table 4. Abilities to discriminate the environmental sounds pre vs postoperatively (n = 22)

Ability / Time	Unable	Able at 30cm	Able at 1 - 2m	Able at > 2m	Sum
Preoperative	10	12	0	3	22
1 month postop	0	7	11	4	22
6 months postop	0	0	12	10	22
1 year postop	0	0	4	18	22

Pre-operatively, all patients were unable to hear the environmental sounds. However, 100% (22/22) patients could tell the different sounds of the environment after cochlear implantation.

3.2.3. The six ling sounds test

Table 5. Ability to recognize the Six Ling sounds pre- and post-operative (n = 22)

Ability / Time	Unable	Able at 30cm	Able at 1 - 2m	Able at > 2m	Sum
Preoperative	14	6	1	1	22
1 month postop	0	10	8	4	22

6 months postop	0	3	8	11	22
1 year postop	0	0	3	19	22

One year after the surgery, all the patients were able to hear the Six Ling sounds from over one meter distance.

Table 6. Ability to discriminate the six Ling sounds pre- and post-operative (n = 22)

Ability / Time	Unable	Able at 30cm	Able at 1 - 2m	Able at > 2m	Sum
Preoperative	15	6	1	0	22
1 month postop	6	8	7	1	22
6 months postop	0	4	12	6	22
1 year postop	0	0	7	15	22

The ability to hear and repeat the six Ling sounds had gained significantly after the surgery.

3.2.4. The free-field test

The free-field hearing test after the surgery has showed that: Postoperatively, approximately 77.3% (17/22) of the patients had hearing thresholds within normal range and the rest (5/22) gained to the level of "mild hearing loss".

4. Discussion

4.1. Main characteristics of the studied subjects

Among 22 patients, 50% (11/22) of them were implanted from 0 to 6 years old, while 36.4% (8/22) were implanted much later when they were 18 or over this age. More importantly, 31.8% or one third of all patients were 3 years old or younger. It is proved that children who received an implant at an early age performed better on all clinical tests than children who received implants at an older age, and adults with long-term prelingual deafness. This age group is also proved to be the most appropriate period for implantation to fully develop the lingual and intellectual functions. Studies of Black [1], Ching [2] and Miyamoto [3] also shared the same perspective in their findings. In addition, this rising number of younger implanted age also indicated the better understanding of parents to hearing loss in children.

No statistically significant differences was found regarding the sex and age groups.

In this study, over two third of our patients (68.2%) had prelingual hearing loss which meant they never heard any sounds before the implantation. Based on many studies, pre-operative lingual ability of patients is a critical indicator for hearing recovery after the surgery. Kaplan and Puterman [4] found that the longer period of none auditory-verbal communication the subjects were in, the poorer the outcomes. Therefore, these patients needed to undergo a prolonged language training course before they can learn to talk. In contrast, this recovery process in the postlingual deafness group could be much more advantage.

Regarding the level of hearing loss, all studied subjects had bilateral severe to profound loss in which PTA ranged from 70dB to 90dB or over 90dB in both ears. These patients gained no benefit with hearing devices in daily communication. These audiological factors have been the cochlear implantation indications approved by FDA since 1980s [5]. The indications have currently been extended to those with hearing loss unilaterally and with a high frequency hearing loss. However, due to our limited practical experience in hearing rehabilitation, we temporarily enrolled patients with bilateral profound hearing loss.

4.2. Cochlear implant surgery

In the studied subjects, 73.9% of them were implanted on the right side. Ideally, cochlear implantations are done on both sides. However, due

to the considerable expense of the surgery, only one of our patients could afford and he/she was implanted both ears. According to Deguine O et al [5], there was no significant difference in results between patients implanted on their dominant side and patients implanted on their nondominant side. When ears are different according to their peripheral factors, the authors suggested implanting the better ear (with nonusable hearing). When both ears are identical, the side of implantation should be the side of handedness laterality to facilitate device manipulation. In our studies, we also prioritized the operation ears on the dominant hand side so that it would be more beneficial for patients during everyday activities and for utilizing the device.

Out of 23 implanted ears, one had facial paralysis postoperatively, and one had eardrum perforated. In the case of facial paralysed, it might be the swelling or stimulus of the VII nerve that caused the temporary problem. He/she totally recovered after one week with steroid treatment. The perforated eardrum was fixed with a temporal fascia graft. In general, these complications were mild and could be managed easily. In the literature, complications of Cochlear implantation can vary from early complications such as tympanic perforations, facial paralysis, cerebrospinal fluid leakage, dizziness and subcutaneous hematoma to late ones as infection at the implanted site, disturbance of the VII nerve and allergy to the magnetic parts of the devices. However, due to the advanced surgical technique used, and the good postoperative care conducted, the complications of the surgery has been gradually minimized [6].

4.3. Hearing recovery postoperation

Postoperative hearing rehabilitation is a difficult and long process which requires much efforts and co-ordination from the receivers, parents and experts. Postoperatively, all 22 subjects participated in a hearing training course. To assess the outcomes, we chose the one month, six month and twelve month-period to ensure all patients could be familiar with their new devices and had had six times of mapping in the first year. The chosen parameters included recognition and ability to discriminate the environmental sounds and Six Ling sounds test. These factors are critical for these patients to early integrate to the sound environment, and allow them being able to learn spoken languages.

The recognition and discrimination of the environmental sounds are the first hearing functions expected post-operatively. Shafiro et al [7] has found that these functions will support patients in daily activities, help them understand alarm sounds and enjoy benefits of cochlear implantation. Our finding showed that many patients were able to recognize and discriminate the environmental sounds even within the 1st week and 1st month post-operatively. One year post-operatively, 81.8% (18/22) of patients could hear the environmental sound from over two meters distance.

Apart from hearing and differentiating the environmental sounds, the receivers need to be able to hear and distinguish the six ling sounds to develop their language. The chosen six sounds are the most frequently met in daily spoken language, and represent various sound frequencies from low frequencies as 250Hz to high frequencies as 8000Hz. These are also the frequencies applied in the pure tone audiological test. In our study, over 90% (21/22 and 20/22) of patients were unable to fully detect and distinguish six Ling sounds pre-operatively (Table 5 - 6). One year post-operation, 68% (15/22) of patients were able to differentiate 6 Ling sounds (Table 6). This was similar to the finding of other studies as LH Chau [8]: 70% of patients recovered their hearing. This is also the vital foundation for hearing loss patients, particularly pre-lingual deafness patients, to learn a language.

All studied subjects gained their hearing to mild or normal in a free field hearing test with the devices activated. The same findings were also published by CM Thanh [9]. This test provided the patients with real life experience when they had the cochlear implants and the hearing aids at the same time. Most of our patients got better when they eventually got used to the devices after one or two year.

5. Conclusion

Cochlear implantation is a safe and reliable treatment for patients with severe to profound hearing loss. Especially in young children, it is optimal for the acquisition of hearing thus promotes development of spoken language. This humanity surgery needed to be extended and developed to restore the normal life for patients with hearing impairment.

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