Original Article

Outcome of Cochlear Implantation in Postmeningitis Profound Sensorineural Hearing Loss at Rajavithi Hospital

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Background: Bacterial meningitis is one of the major factors in the etiology of acquired sensorineural hearing loss in children and adults. Cochlear implantation in these patients is challenging because of inner ear ossification and fibrosis, and this procedure sometimes achieves poorer outcomes in this scenario than with other causes of sensorineural hearing loss. There has been little research into the factors affecting the outcomes of this procedure.

Objective: To evaluate the outcomes of cochlear implantation in patients with postmeningitis profound sensorineural hearing loss and to evaluate the factors that affect the results.

Materials and Methods: A retrospective review was conducted of thirty patients who were diagnosed with post meningitis profound hearing loss and underwent cochlear implantation at Rajavithi Hospital between 2001 and 2016. Preoperative language status, duration of deafness, preoperative imaging, and degree of electrode insertion were recorded. Categories of auditory performance-II test (CAP-II) was evaluated in all cases, one year postoperative.

Results: Thirty postmeningitis deafness patients underwent cochlear implantation. The median age at diagnosis of meningitis and age at implantation were 41 years (range 1 to 75) and 49.50 years (range 3 to 75), respectively. The median duration of deafness was 12 months (range 4 to 300), and the overall mean CAP-II at one year after surgery was 5.47±2.21. The postlinguistic group had a significantly higher CAP-II score than the prelinguistic one (p=0.006). Electrodes were successfully totally inserted in 19 patients (63.3%) and partially inserted in 11 (36.7%). The average CAP-II score in the group with fully-inserted electrodes was significantly higher than in the group with partially-inserted electrodes (p=0.045). There was no correlation between CAP-II score and age at meningitis diagnosis (p=0.069), age at time of surgery (p=0.105), duration of deafness (p=0.506), or preoperative CT (p=0.228) or MRI abnormality (p=0.078).

Conclusion: Cochlear implantation in patients with postmeningitis profound hearing loss had high success rates and favorable outcomes. Preoperative language status and degree of electrode insertion were factors that affected auditory performance results.

Keywords: Cochlear implantation, Postmeningitis hearing loss, Sensorineural hearing loss, Meningitis, Rajavithi Hospital

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Bacterial meningitis is one of the major factors in the etiology of acquired sensorineural hearing loss in children and adults, and there is a 6% to 16% chance that these patients will be suffering from hearing loss(1), with sequelae usually involving bilateral permanent profound hearing loss. Extension of disease of the inner ear causes inflammation in the cochlea leading to damage to the organ of Corti and subsequent fibrosis and ossification(2). The common bacterial pathogens involved are *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Neisseria meningitidis*.

In Thailand, *Streptococcus suis* infection, a gram-positive, peanut-shaped bacterial pathogen found in pigs, is caused by eating under-cooked pork and is among the most common organisms that lead to complications in terms of profound hearing loss in meningitis(3). Infection can result from exposure to bacteria via cuts or abrasions to the skin, or consumption of raw meat. Deafness occurs in more than one-half of the patients and is usually severe and bilateral(4).

Cochlear implantation in these patients is challenging because a degree of inner ear ossification and fibrosis can occur rapidly after an infection(5) and the procedure sometimes achieves poorer outcomes compared with its use for other causes of sensorineural hearing loss(6-8). To date, few studies

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Table 1. Category of Auditory Performance-II

Category	Criteria
0	No awareness of environmental sounds or voice
1	Awareness of environmental sounds
2	Response to speech sounds
3	Identification of environmental sounds
4	Discrimination of speech sounds without lipreading
5	Understanding of common phrases, e.g., “open the door”, “push the car” without lipreading
6	Understanding of conversation without lipreading
7	Use of telephone with known speaker
8	Following group conversation in reverberant room such as a classroom or restaurant where there is some interfering noise
9	Use of telephone with unknown speaker in an unpredictable context

have been performed to investigate the factors that affect the outcomes of postmeningitis cochlear implantation(5,9,10).

The aim of the present study was to evaluate the outcomes of cochlear implantation in patients with postmeningitis profound sensorineural hearing loss and to evaluate the factors that affected the results.

Materials and Methods

Patients diagnosed with profound hearing loss resulting from bacterial meningitis and underwent cochlear implantation between 2001 and 2016 were included in the present study. The research was approved by the Ethical Committee of the Institute (RAJ-IRB 011/2561) and all participants gave informed consents. All patients had a history of bacterial meningitis confirmed by culture. Deafness was confirmed by standard audiometry and auditory steady state response. Each operation was performed by an experienced surgeon using postauricular transmastoid facial recess approach cochleostomy. All the patients were implanted with Cochlear Nucleus CI24RE Contour Advance electrode. Data collected included patient demographics, preoperative language status, age at time of surgery, duration of deafness, preoperative imaging, and degree of electrode insertion. The outcomes at 1 year postoperatively were recorded using the Categories of Auditory Performance-II score (CAP-II) (Table 1).

Data analysis and statistical processing

Data analyses were performed using IBM SPSS Statistics, version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean ± standard deviation (SD) or median (range) as appropriated for continuous data, and as number (percentage) for categorical data. Continuous variables were compared for significant differences between groups using Student t-test or Man-Whitney U-test. A p-value of less than 0.05 was considered significant.

Results

Thirty postmeningitis deafness patients underwent cochlear implantation at Rajavithi Hospital between 2001 and 2016. The demographic data is shown in Table 2. The thirty patients had successful implantation without any complications. There were 19 males (63.3%) and 11 females (36.7%) with a median age at meningitis diagnosis of 41 years (range 1 to 75). The median age at implantation and duration of deafness were 49.50 years (range 3 to 75) and 12 months (range 4 to 300), respectively. There were four prelinguistic and 26 postlinguistic patients in the present study.

The overall mean CAP-II at one year after surgery was 5.47±2.21, and mean CAP-II scores in the postlinguistic group were significantly higher than those of the prelinguistic patients (5.88±1.71 and 2.75±1.71, respectively, p=0.006). Computed tomography (CT) scan revealed ossification of cochlea in four patients and magnetic resonance imaging (MRI) detected fibrosis in seven patients.

There was no significant difference in postoperative CAP-II score between patients with abnormal CT or MRI and those in the normal group (p=0.228 and 0.076, respectively). Electrodes were fully inserted in 19 patients (63.3%) and partially inserted in the other 11 (36.7%). The average CAP-II score in the group with fully-inserted electrodes (mean 6.05±1.84) was significantly higher than in subjects with partial insertion (mean 4.45±2.51, p=0.045). There was no correlation between CAP-II score and age at meningitis diagnosis (p=0.069), age at time of

Table 2. Demographics of patients (n=30)

Factors	n (%)
Sex	
Male	19 (63.3)
Female	11 (36.7)
Age at meningitis diagnosis (years); median (range)	41.00 (1 to 75)
Age at implantation (years); median (range)	49.50 (3 to 75)
Duration of deafness (months); median (range)	12.00 (4 to 300)
CAP-II; mean±SD	5.47±2.21
Language status	
Prelinguistic	4 (13.3)
Postlinguistic	26 (86.7)
CT	
Normal	14 (77.8)
Ossified	4 (22.2)
MRI	
Normal	11 (61.1)
Fibrosis	7 (38.9)
Electrode insertion	
Full	19 (63.3)
Partial	11 (36.7)

CAP-II=Category of Auditory Performance-II; CT=computed tomography; MRI=magnetic resonance imaging; SD=standard deviation

Table 3. Factors associated with CAP-II (n=30)

Factors	n (%)	CAP-II; mean±SD	p-value
Sex			
Male	19 (63.3)	5.89±2.03	0.167
Female	11 (36.7)	4.73±2.41	
Language status			
Prelinguistic	4 (13.3)	2.75±1.71	0.006*
Postlinguistic	26 (86.7)	5.88±1.99	
CT			
Normal	14 (77.8)	5.86±2.54	0.228
Ossified	4 (22.2)	5.00±0.00	
MRI			
Normal	11 (61.1)	6.82±2.14	0.078
Fibrosis	7 (38.9)	4.86±2.00	
Electrode insertion			
Full	19 (63.3)	6.05±1.84	0.045*
Partial	11 (36.7)	4.45±2.51	

CAP-II=Category of Auditory Performance-II; CT=computed tomography; MRI=magnetic resonance imaging; SD=standard deviation

* p<0.05 was considered significant

surgery (p=0.105), or duration of deafness (p=0.506) as shown in Table 3.

Discussion

Cochlear implantation in postmeningitis patients is challenging and should be done by an experienced ear surgeon, as cochlear ossification and fibrosis complicate the procedure. Different surgical techniques have been reported in the literature[11], but the advanced drill-out procedure is the most commonly performed modality. Senn et al reported that retrograde array insertion with the cochleostomy near the apex was an efficient alternative approach in cases of basal turn ossification[12]. Few studies have reported the outcomes of cochlear implantation in postmeningitis patients, but its overall outcomes in postmeningitis deafness have been found to be unpredictable and usually poorer than in cases of other causes of deafness[1,6-8]. Some research articles have reported comparable outcomes in spite of cochlear ossification[9,10,13].

In the present study, cochlear implantation was performed in 30 cases between 2001 and 2016. The author used standard cochleostomy with the advanced drill-out technique. All the operations were successful without complications, and overall CAP-II scores at one year were favorable with mean=5.47. Cochlear implantation was possible in all cases despite preoperative abnormal CT and MRI demonstrating intra-cochlear ossification and fibrosis, respectively. Electrode insertion was classified as partial or total.

Helmstaedter et al[6] and Yan et al[14] reported that cochlear implant results in an obliterated and ossified cochlea group were poorer than in a control group. Tokat et al, reported that auditory performance scores were comparable between patients who received full and partial electrode insertion[10].

In the present study, presentation with cochlear ossification or fibrosis did not affect surgery success or postoperative CAP-II scores, but the degree of electrode insertion had a significant impact on the outcomes. Patients in the group with fully-inserted electrodes had significantly higher CAP-II scores than their counterparts with partial insertion. Preoperative language status significantly affected postoperative CAP-II scores, with the postlinguistic group achieving a significantly higher CAP-II score than patients in the prelinguistic group. Yan et al also reported better outcomes in their prelinguistic postmeningitis group[14]. Other factors such as age at time of surgery and duration of deafness before implantation did not affect the outcomes in terms of surgery success or

CAP-II score.

The present study had some limitations because of its retrospective nature. The intraoperative findings regarding difficulty and degree of ossification and fibrosis were not well-recorded or discussed, and both CT and MRI were not performed in all cases, however, Yan et al has reported that CT and MRI had comparable value in predicting the occurrence of ossification in cochleas[14].

Conclusion

Cochlear implantation in postmeningitis profound hearing loss achieved high success rates and favorable results. Preoperative language status and degree of electrode insertion were the factors that affected auditory performance outcomes.

What is already known on this topic?

Cochlear implantation in postmeningitis profound sensorineural patients has been reported to have unpredictable outcomes, and the factors that affect these outcomes are still unclear.

What this study adds?

The results of this study show that cochlear implantation in cases of postmeningitis profound hearing loss yields a high success rate and favorable results. Preoperative language status and degree of electrode insertion are factors that affect auditory performance outcomes.

Conflicts of interest

The authors declare no conflict of interest.

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