A Case Report on Cochlear Implant in a Pediatric Patient

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KEYWORDS

Cochlear implant, Hearing loss, Auditory neuropathy, Hybrid implants,

Tympanotomy

ABSTRACT:

Children's quality of life and development can be significantly affected by hearing loss. Cochlear implants have revolutionized the field of auditory rehabilitation, providing individuals with severe to profound hearing loss an opportunity to experience sound and improve their overall quality of life. The cochlear implant developed from an initial attempt to restore hearing by directly stimulating the hearing nerve to a commercially accessible technology that has helped hundreds of thousands of deaf patients hear to varied degrees.

Both the cochlear implant that enables the deaf youngster to develop almost normal speech production as well as comprehension and the one that enables the individual who has lost their hearing to restore the ability to communicate on the telephone.

In this case study, a girl aged three years and nine months presented with speech impairment. The girl was identified as having bilateral significant hearing loss, which was treated with a cochlear implant and speech therapy. The case report discusses the variety of treatment modalities for the cochlear implants. The aim is to provide a comprehensive understanding of cochlear implantation, its impact on recipients, and the ongoing advancements in this evolving field.

Introduction

Cochlear implants represent a breakthrough in auditory science, aiming to restore hearing in individuals with significant hearing impairment. It is a sophisticated electrical device that helps people with severe to profound hearing loss perceive sound. Cochlear implants function by directly stimulating the auditory nerve to convey signals to the brain, avoiding damaged or non-functioning regions of the ear, in contrast to hearing aids, which enhance sounds. Many people with severe to profound hearing loss have had their lives completely transformed by innovative cochlear implants. They offer a great way to enhance communication and establish a stronger bond with the auditory world, making them a worthwhile option for people who might not benefit from conventional hearing aids. While cochlear implants have brought about remarkable improvements in the educational outcomes of children with hearing loss, it's essential to note that individual experiences may vary. For implant centres around the world, cochlear implant surgeries and subsequent rehabilitation are often simple procedures. The technique has had a stronger influence on improving the schooling of kids who are implanted early and are born with substantial hearing loss. The majority of these youngsters go to regular schools and speak informally. It is acknowledged that there is an enormous gap in the management of acute to severe hearing loss in adults, particularly the elderly, at the other end of the age spectrum. The consequences of these unmet needs can have a serious impact on a person's health and place a costly burden on society.

According to estimates, the prevalence of hearing loss in children and neonates ranges from 1.1 to 3.5 per 1,000 screened cases [1]. By the age of 18, up to 20% of children have some degree of hearing loss, emphasising the need for adequate diagnosis and intervention methods to stop the detrimental effects of hearing loss. If ignored, uncorrected hearing loss can lead to serious issues such as delayed speech and language development, vestibular dysfunction, elevated anxiety and depression, and lowered self-esteem and general well-being [1]. According to Cheng's estimation, there could be as many as 2,000 youngsters in the US who could benefit from cochlear implants [2].

Case Presentation

The case report is of a female youngster aged three years and nine months who was nonverbal was presented to the outpatient department. She underwent a complete Ear nose throat (ENT) examination. Her ENT evaluation was within the age-appropriate ranges. The pure tone audiometry examination showed bilateral profound hearing loss as hearing level in decibels is around 80-100 db as shown in figure 1. Typanometry which examines the middle ear showed bilateral type A curve which suggest absence of middle ear pathology as shown in figure 2. Her hearing was then tested using otoacoustic emission (OAE), which revealed bilateral profound hearing loss as shown in figure 3 and figure 4. The brainstem auditory evoked potential (BAEP) revealed bilateral profound hearing loss in figure 5.

Figure 1: Pure tone Audiometry

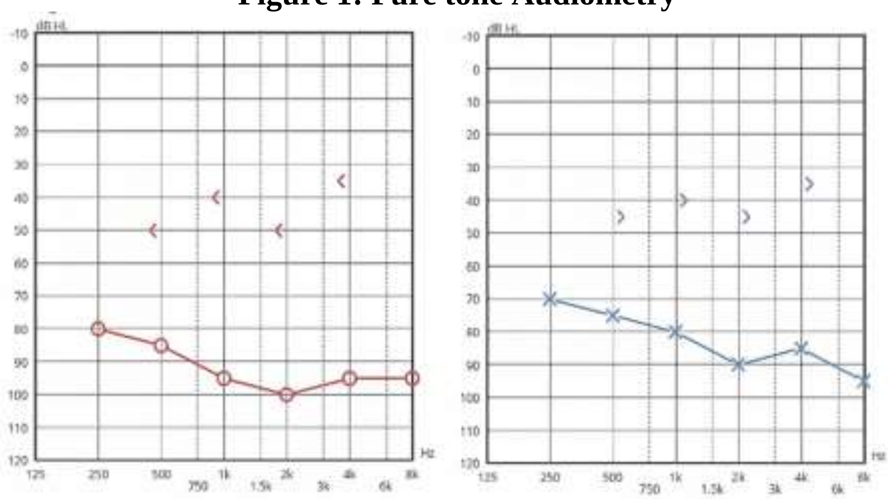


Figure 2: Tympanometry (Type A curve)

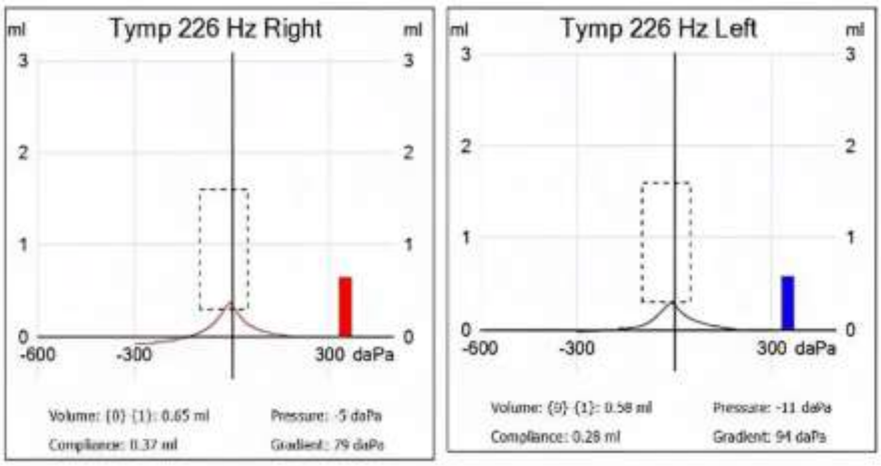
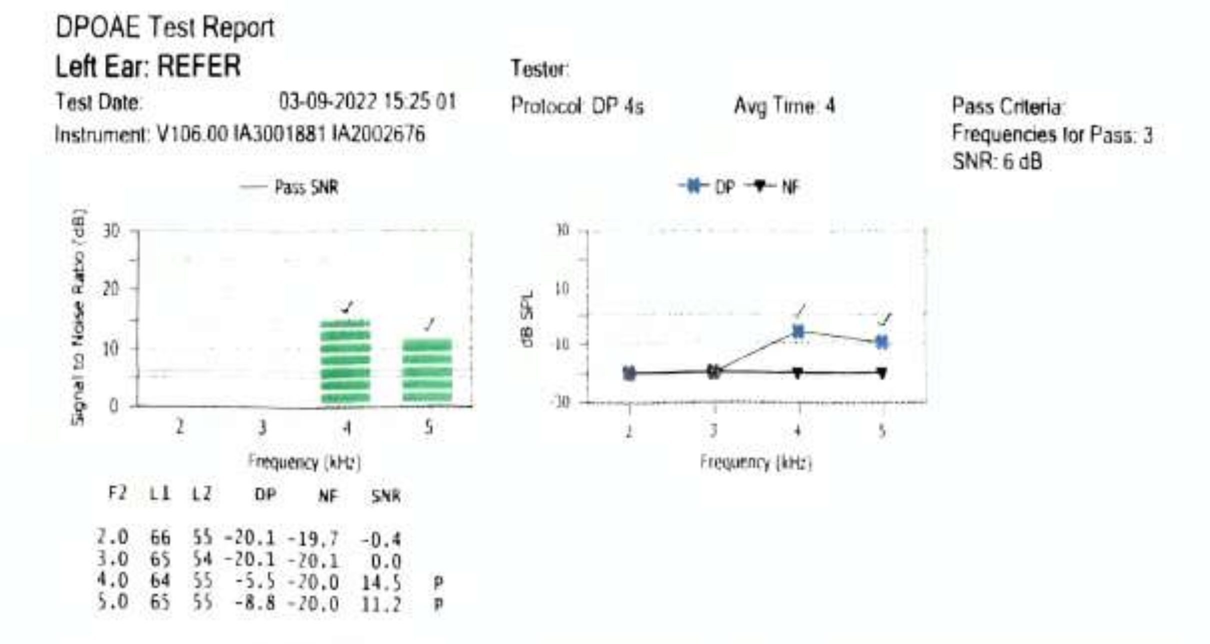


Figure 3: OAE testing (Left ear)

OAE- Oto Acousitic Emission (OAE)

DPOAE- Distortion product otoacoustic emissions



DPOAE Test Report

Left Ear: REFER

Test Date: 03-09-2022 15:25:01

Instrument: V106.00 IA3001881 IA2002676

Tester:

Protocol: DP 4s Avg Time: 4

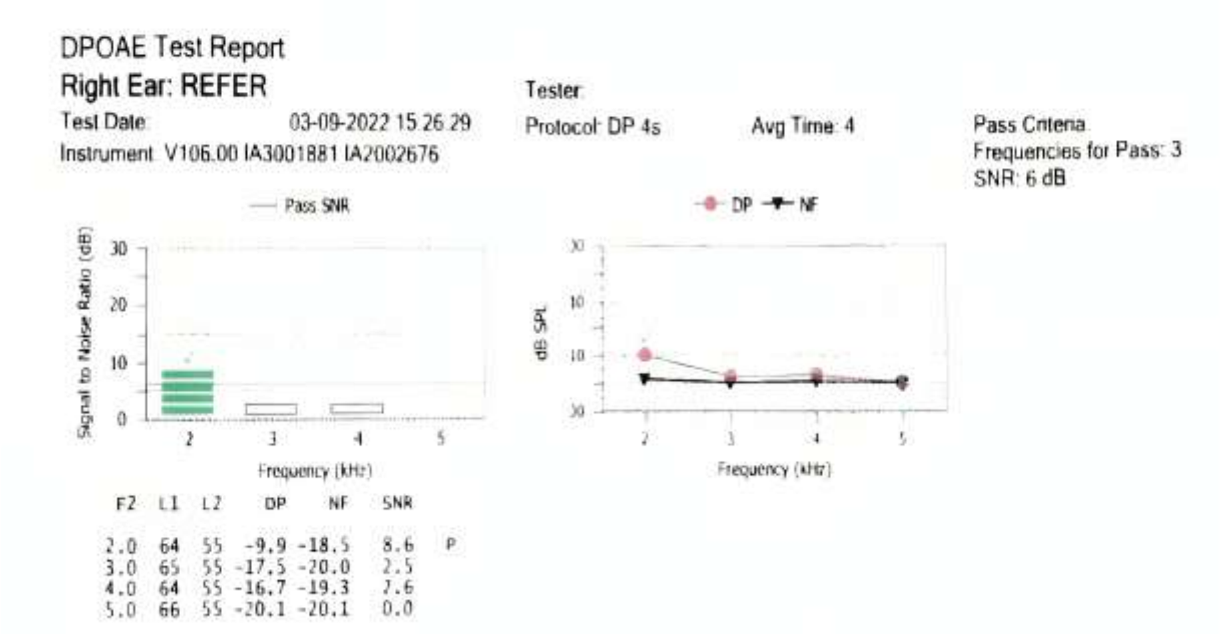
Pass Criteria:
Frequencies for Pass: 3
SNR: 6 dB

F2	L1	L2	DP	NF	SNR	
2.0	66	55	-20.1	-19.7	-0.4	
3.0	65	54	-20.1	-20.1	0.0	
4.0	64	55	-5.5	-20.0	14.5	P
5.0	65	55	-8.8	-20.0	11.2	P

Figure 4: OAE testing Right ear

OAE- Oto Acoustic Emmission

DPOAE-Distortion product otoacoustic emissions



DPOAE Test Report

Right Ear: REFER

Test Date: 03-09-2022 15:26:29

Instrument: V106.00 IA3001881 IA2002676

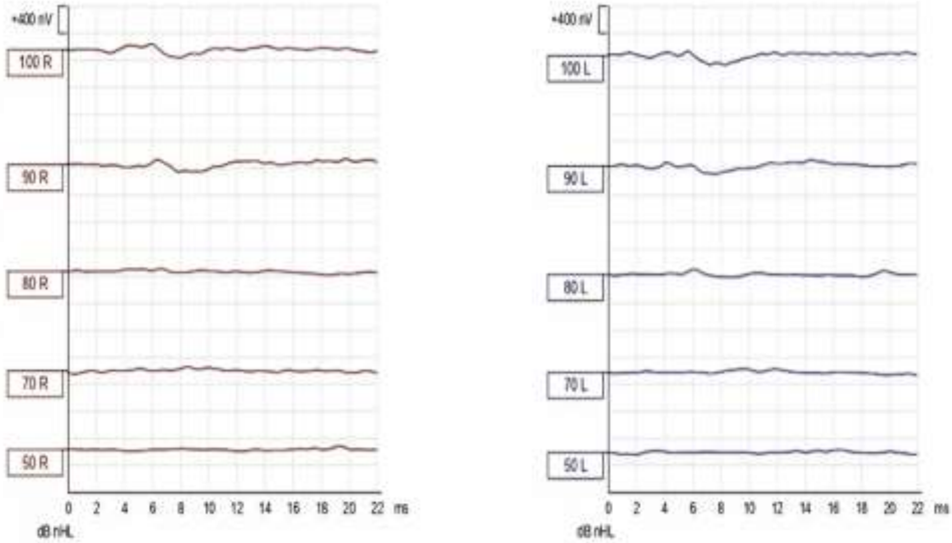
Tester:

Protocol: DP 4s Avg Time: 4

Pass Criteria:
Frequencies for Pass: 3
SNR: 6 dB

F2	L1	L2	DP	NF	SNR	
2.0	64	55	-9.9	-18.5	8.6	P
3.0	65	55	-17.5	-20.0	2.5	
4.0	64	55	-16.7	-19.3	2.6	
5.0	66	55	-20.1	-20.1	0.0	

Figure 5: Brain Stem Auditory Evoked Potential (BAEP)



The child was thoroughly examined after being diagnosed with bilaterally significant hearing loss. Prior to taking a complete family history, which was also unimportant, the prenatal, natal, and postnatal medical histories were thoroughly reviewed. The child's developmental milestones were assessed and found to be typical. Her mental maturity was evaluated by having her intelligent quotient (IQ) tested by a clinical psychologist, which again revealed no abnormalities. In order to rule out any more potential causes of any additional linked congenital defects, a paediatrician was consulted. Using high-resolution computerised tomography,the development of the facial and cochlear nerves, which were examined using a temporal bone and an MRI skull, was shown to have occurred normally. The child was offered a hearing aid trial; however, no response was received.

Following a thorough examination and evaluation, the patient's parents received counselling regarding the child's hearing impairment and were encouraged to have a cochlear implant as soon as possible for the benefit of the child. With the help of a cochlear implant, her communication and social development can be better facilitated. The parents were persuaded, and a cochlear implant was performed under general anaesthesia followed by speech therapy, keeping in mind the age of cerebral plasticity. After receiving speech treatment for a year, the child has good speech and understanding, is enrolled in a regular school, has become quite confident, and is just like any other typical youngster.

Discussion

A critical assessment of the clinical outcomes and the impact of cochlear implants on recipients is presented. Severe or profound hearing loss has a significant negative impact on the nation's economy. In comparison to 18% of the population as a whole, 42% of those evaluated with severe or profound hearing damage within the ages of 18 and 44 do not have a job [3,4].Despite significant investments in their education, children with severe or profound hearing loss dropped out from high school at a rate of 44%, compared to the 19% of students with normal hearing. Compared to 13% of youngsters with normal hearing, just 5% of people who are severely to profoundly deaf graduate from the college(3). From preschool through grade 12, the expense of educating a child who is severely to profoundly deaf is significantly higher and is close to $1,000,000 per child, which is 50 times more expensive than educating a child with typical hearing [5,6]. In contrast, the expense for cochlear implantation and related rehabilitation therapies is affordable. The savings in educational expenses alone would cover the whole cost of implanting cochlear implants for all the 10 implant recipients, even if it only moves one child out of every ten into a regular classroom. In, preoperative evaluation, Pure tone audiometry & speech discrimination testing are the first steps in the initial assessment for cochlear implant candidature in post lingually deaf individuals. Potential candidates for cochlear implants often have pure tone averages above 50 dB and a conventional speech discrimination score between 50 and 60%.

Once it is established whether a person constitutes a strong audiological applicant, a medical assessment is required to determine whether the individual is healthy enough to undergo surgery with reasonable risks. It is necessary to undergo a radiographic examination of the temporal bone to look for any potential anatomical changes that can make the procedure dangerous. could necessitate making changes to the standard surgical approach.Magnetic resonance imaging (MRI) along with high resolution computer tomography are two radiographic methods used to evaluate cochlear implant candidates. When compared to high resolution CT screening, MRI is more accurate at detecting early labyrinthine ossificans. Therefore, for the purpose of identifying post-meningitis Endo cochlear blockage, MRI is the preferred diagnostic technique [7,8,9]. A missing and hypoplastic cochlear nerve can be shown on an MRI, which is a contraindication to cochlear implant surgery. Anomalies of the central nervous system that can impair the success of implant can also be accurately identified on MRI.

On psychological evaluation of the child's mental capacity, their expectations for performance after the implant, and any family concerns that can influence implantation and performance after the implant are the main goals of a psychological assessment. Nowadays, with advancements into cochlear implant surgery, the better hearing ear is operated on under the assumption that it is more likely to contain remaining neural parts and so provide the potential for improved performance. The choice of place could be affected by anatomical factors. The ear on the other side may be chosen if one of the ears is noticeably hypoplastic or dysplastic. It is best to choose the side with greater vestibular function. The better side will be implanted if the central nervous system is activated as determined by Single Photon Emission CT, Functional MRI, & Enhanced CorticalAuditory Electrophysiology prior to surgery [10 -13]. In the case study, the right side of ear was implanted.

Age of implantation: The majority of professionals studying language and speech development have long held the intuitive belief that outcomes will be degraded the younger the implantation age. 100 kids with implants between the ages of one and ten were examined by Connor et al. A growth curve analysis showed that, in addition to the previously mentioned benefit related to the duration of usage, earlier implantation provided an additional advantage. They came to the conclusion that having kids before reaching the age of two and a half certainly had benefits [14-16]. Conoor et al. have demonstrated that giving children implants within 2 and a half years significantly improves their speech and language outcomes [16]. According to research by Moog and Geers, reading and language proficiency at a normal level are related to implantation occurring at a younger age [17]. According to Cheng and colleagues' meta-analysis, a younger age at implantation is linked to faster improvements in speech perception [18]

Auditory neuropathy: One recently discovered kind of sensory neuronal hearing loss is a condition known as auditory neuropathy (auditory desynchrony). In the context of typical middle ear functions, it is characterised as a state in which otoacoustic emissions exist while auditory brainstem response waveforms are lacking. As per the observations of Shallop and colleagues,in conditions of auditory neuropathy, cochlear implantations have had positive effects [19]. Bilateral implantation: Bilateral listeners may benefit from the use of two implants in a number of ways, including increased speech comprehension. As per the observations made by D. Haese and colleagues, the advantages of bilateral implantation have been shown in a study of 22 individuals with bilateral implants [20].

Cochlear implant electrode arrays: The two forms that are commercially available are pre-curved modiolar hugging (MH) electrode arrays and straight lateral wall (LW) electrode arrays. At present, there are various lengths of straight LW electrode arrays that facilitate insertion over a variety of cochlea sizes. On the other hand, pre-curved MH electrodes are typically limited to covering the basal turn of the cochlea due to manufacturing constraints. A certain amount of intra-cochlear trauma can be brought on by pre-curved MH electrodes as well as straight LW electrodes. It is important to detect the existence of deformed cochleae and select the proper electrodes for each individual cochlea [21]. Surgical procedure: The conventional method of surgery, known as the transmastoid approach, begins with an antromastoidectomy and proceeds to a posterior tympanotomy via the facial recess, a round window technique, or promontorial cochleostomy, as the last step [22]. For a number of years, this surgical method has been employed frequently, with extremely positive outcomes when carried out by skilled otological surgeons. The primary challenge with this strategy is the possibility of injuring facial nerves [23]. The endomeatal approach is one of the nonmastoidectomy techniques used in surgery. This makes it possible to position the array through the round window and external auditory canal in an ideal and trauma-free insertion plane [22, 24].

Conclusion

Cochlear implants have come a long way since their inception, significantly impacting the lives of individuals with severe hearing loss. This case study provides a comprehensive overview of cochlear implant technology, emphasizing its current state, and potential future advancements. In this case study, a three-year-and-nine-month-old girl in this instance had difficulty speaking. She was found to have a substantial hearing loss on both sides. The patient received speech therapy and a cochlear implant as part of their treatment plan. The case report covered a number of cochlear implant-related therapy options. The ongoing commitment to research and innovation in this field promises continued improvements in auditory rehabilitation and the overall well-being of cochlear implant recipients.

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