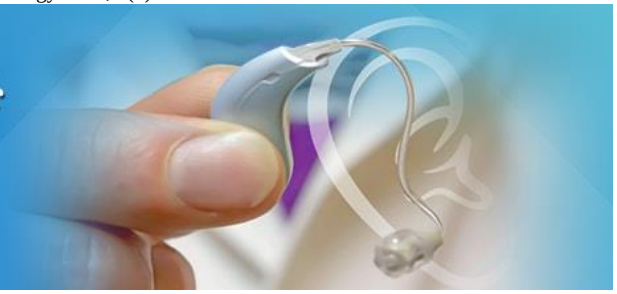
International Journal of Speech and Audiology



E-ISSN: 2710-3854
P-ISSN: 2710-3846
IJSA 2023; 4(2): 35-38

www.rehabilitationjournals.com
Received: 06-06-2023
Accepted: 18-07-2023

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Unusual presentation of hearing loss post SARS-COVID, meningitis and ototoxicity in neonate: A case study

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Abstract
Objective: In India, hearing loss is the most common sensory deficit affecting persons across all age groups. Particularly, hearing loss in neonates ranges between 1.59 and 8.8 per 1000 births. Hearing loss in neonates can be caused due to bacterial or viral infections, congenital malformation of the auditory system, maternal factors, family history, birth complications, etc., this study aims to describe a child diagnosed with bilateral profound sensory neural hearing loss with a constellation of risk factors for hearing loss.
Design: Complete audiological evaluation was carried out on a single subject on two occasions.
Study sample*:* A 58days old, term female child with SARS COVID reactive antibodies on the 8th day of life, resolved *Elizabethkingia meningoseptica* and tetraventricular hydrocephalus, seizures post sequelae.
Results: All audiological tests reveal severe to profound sensory neural hearing loss.
Conclusion: This case study is an attempt to highlight the presence of hearing loss in a single infant with multiple possible etiologies.

Keywords: Bilateral profound sensory neural hearing loss, *Elizabethkingia meningoseptica*, SARS COVID, tetraventricular hydrocephalus

Introduction
Hearing loss is the most common sensory deficit in humans. As per WHO estimates in India, there are approximately 63 million people, who are suffering from Significant Auditory Impairment; this places the estimated prevalence at 6.3% in the Indian population. As per the NSSO survey, currently, 291 persons per one lakh population are suffering from severe to profound hearing loss (NSSO, 2001). Of these, a large percentage are children between the ages of 0 to 14 years. Neonatal hearing screening is mandated to detect hearing impairment at an early stage to pave way for early diagnosis and early intervention. This significantly improves the prognosis of auditory, speech, and language development in young children.
Major causative factors for hearing loss in neonates are attributed to congenital malformations of the auditory system, and infections of the central nervous system and/or of the ear. Other etiologies may also include birth complications like hyperbilirubinemia, low birth weight, birth asphyxia, and maternal infections like TORCH, CHARGE, etc.
This study aims to discuss the case of a 58days old baby with clusters of possible causative factors for hearing loss.

Case report
A 58 days old, term, LSCS female child was brought to the hospital for a complete audiological evaluation.
Pre-natal and peri-natal history was uneventful. APGAR scores = 6 at 1 minute of life and 7 at 5 minutes of life. Post-natal history revealed the following:
On 2nd day of life, the child's mother perished due to delivery complications and renal cortical necrosis. The mother's reports revealed she was SARS- Covid positive. Hence, the child was shifted to NICU at a private hospital. On the 8th day of life, the child developed a fever. Septic work was done and the child was started on empirical antibiotics intravenously for 5 days (Inj. Ampicillin, Inj. Amikacin). Blood culture and CSF showed the presence of *Elizabethkingia meningoseptica*. The child was given Inj.

Ciprofloxacin according to sensitivity patterns. The antibody test for Covid 19 showed reactive antibodies and the child was started on Inj. Dexamethasone. The child was discharged by the father against medical advice. On the 33rd day of life, the child had a low-grade fever and one episode of seizure. CT-Brain revealed Tetra ventricular, obstructive hydrocephalus, and ventriculomegaly possibly due to meningitis.

Table 1: List of clinical findings from the child birth till 28th day of hospitalization

Time	Events	Clinical findings
Birth	Full term, LSCS. Well baby.	APGAR scores = 1'6; 5'7
2nd day	Mother died. Child shifted to NICU.	
8th day	Child developed fever and was started on antibiotics.	Blood and CSF showed *Elizabethkingia meningoseptica*.
14th day	Discharged against medical advice.	
28th day	Low grade fever. One episode of seizure. Child was started on strong antibiotics and antiepileptic drugs.	CT – Brain shows Tetraventricular, obstructive hydrocephalus and ventriculomegaly.

Audiological evaluation results

Otoacoustic emissions (OAE)

OAE testing was carried out using Neuroaudio OAE instrument in a sound - treated room and revealed absent OAE at all frequencies suggesting inadequate functioning of outer hair cells.

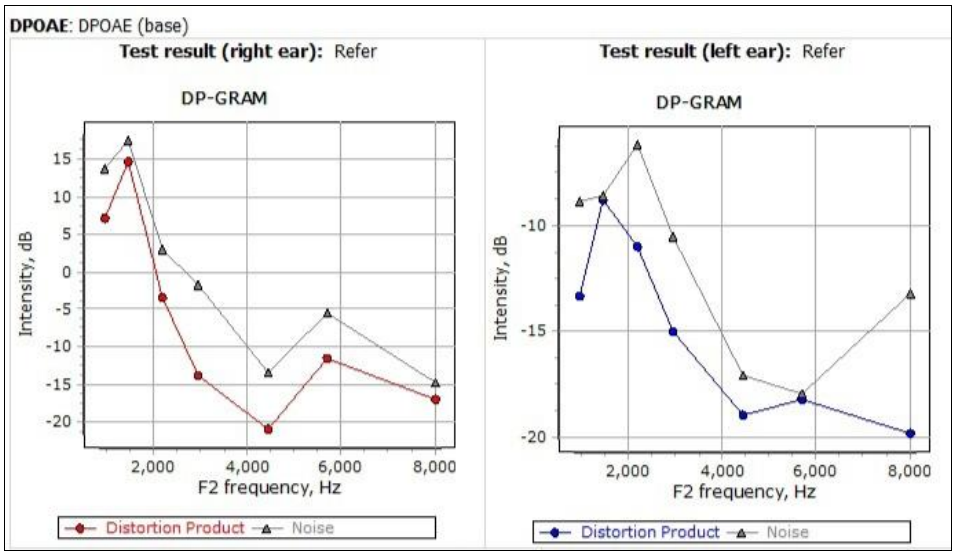

Fig 1: Distortion Product Otoacoustic Emissions (DPOAE) Testing: DP Gram of the child showing inadequate functioning of outer hair cells

DPOAE Analysis (Right ear)

F2, Hz	F1, dB	F2, dB	DP, dB	Noise, dB	SNR, dB	OAE
988	63.4	52.0	7.06	13.75	-6.7	✘
1481	63.5	52.4	14.65	17.52	-2.9	✘
2222	65.6	54.9	-3.38	3.01	-6.4	✘
2963	66.7	54.1	-13.76	-1.63	-12.1	✘
4444	67.0	51.3	-20.93	-13.45	-7.5	✘
5714	67.5	60.3	-11.52	-5.44	-6.1	✘
8000	67.7	56.7	-16.90	-14.69	-2.2	✘

DPOAE Analysis (Left ear)

F2, Hz	F1, dB	F2, dB	DP, dB	Noise, dB	SNR, dB	OAE
988	63.0	53.5	-13.32	-8.87	-4.5	✘
1481	64.2	54.5	-8.84	-8.65	-0.2	✘
2222	65.1	55.1	-10.99	-6.22	-4.8	✘
2963	65.6	55.2	-15.02	-10.54	-4.5	✘
4444	65.4	55.3	-18.91	-17.09	-1.8	✘
5714	65.9	55.1	-18.22	-17.95	-0.3	✘
8000	65.8	55.6	-19.81	-13.24	-6.6	✘

Fig 2: DPOAE Analysis Table for right and left ear respectively

Auditory brainstem response (ABR)

Auditory brainstem response was tested using Neuroaudio instrument and revealed no discernable peaks at 105dBnHL at the repetition rate of 11.1 clicks/sec suggestive of severe to profound sensory neural hearing loss.

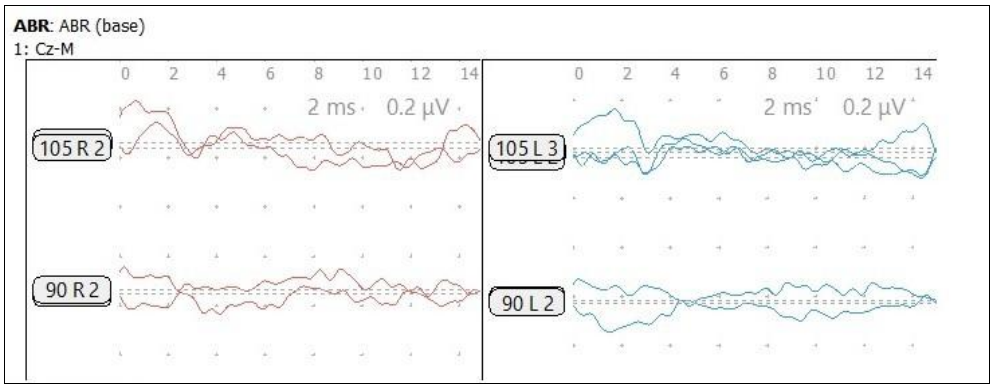

Fig 3: Auditory Brainstem Response (ABR): result of right ear and left ear respectively

The child was scheduled for further assessment to be done at 3 months of age. At 3 months, ABR testing was carried out again.

Auditory brainstem response (ABR) results: No peaks could be traced at 105dBnHL at the repetition rate of 11.1 clicks/ sec suggestive of severe to profound sensory neural hearing loss.

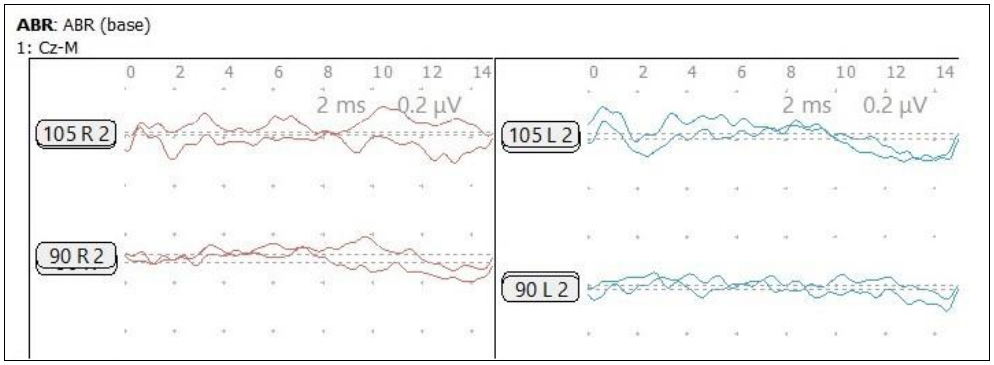

Fig 4: Auditory Brainstem Response (ABR) test results of right and left ear respectively during the 2nd follow up

Provisional Diagnosis: Bilateral profound sensory neural hearing loss.

Discussion

Bacterial meningitis is one of the leading causes of hearing loss in infants. It is an acute central nervous system infection that can result in brain damage and hearing loss among those who survive the disease. The severity and course of hearing loss depend upon the causative pathogen. The most common causative microorganisms are Streptococcus pneumonia, Group B Streptococcus, Neisseria meningitides, Haemophilus influenza, Listeria monocytogenes, and Escherichia coli.

In this case report, the child was found to be diagnosed with *Elizabethkingia meningoseptica* meningitis, *Elizabethkingia meningoseptica* is an unusual type of bacterium causing meningitis.

It is a gram-negative bacteria and was named after the American bacteriologist Elisabeth O. King, who in 1959 discovered Flavobacterium meningoseptica, which, until 1994, had been the previous name for *Elizabethkingia meningoseptica*. It was reclassified into the genus Chryseobacterium (1994-2005). It is commonly found in soil and water, although it is also involved in hospital emergent infections related to contaminated medical equipment, especially in neonatal wards. Elderly, newborns, and immunocompromised patients are most susceptible to this infection, with recorded case-fatality rates high. The diagnosis of Elizabethkingia infection is based on cultures from blood samples.

Prolonged use of immunosuppressants, underlying co-morbid medical conditions, prolonged hospital stay, indwelling central venous catheter, or other invasive devices are some of the risk factors associated with the acquisition of this infection. Another major contributing factor is the prolonged use of broad-spectrum antibiotics.

It has a unique antibiotic susceptibility pattern and is resistant to many antibiotics commonly used to treat infections caused by Gram-negative bacteria such as aminoglycoside, beta-lactam antibiotics, tetracycline, and chloramphenicol. However, they are highly susceptible to clindamycin, erythromycin, ciprofloxacin, cotrimoxazole, and quinolones generally used to treat Gram-positive bacterial infections. *Elizabethkingia meningoseptica* is an emerging concern for medical professionals due to its nosocomial spread and multidrug-resistant properties. Studies and case reports about this type of meningitis and its sequelae are haphazard and minimal.

The presence of SARS-COVID virus in the mother and reactive antibodies in the infant rise to suspicion of a possible cause of hearing loss as SARS-CoV-2 PCR positivity in pregnancy is significantly associated with an

increased risk of abnormal NHS results. COVID-19 is an acute respiratory tract infection, subdivided into mild to moderate, severe, and critical types. Symptoms of COVID-19 include fever, cough, myalgia, fatigue, and dyspnea. Disease manifestations can vary significantly, from a cough or sore throat to acute respiratory distress syndrome (ARDS), respiratory failure, and death. COVID-19 disease course shows acute progression, and the current lack of therapy allows for the infection to become life-threatening. It is a neurotropic virus that can reach the cranial nervous system by anterograde and retrograde transport with the help of motor proteins through sensory and motor nerve endings, glial tissues, neurons, and the brain vasculature, making them a viable SARS-CoV-2 target. A major concern of SARS-CoV-2 infection in pregnant women is vertical maternal-fetal transmission with an exception of intrauterine spread.

Another major concern, in this case, is the use of ototoxic antibiotics from the eighth day of life. Ototoxicity refers to the toxic effects of various chemical agents, especially drugs. Most ototoxic medications belong to a class of antibiotics called aminoglycosides, such as amikacin, gentamicin, kanamycin, neomycin, netilmicin, streptomycin, and tobramycin. Aminoglycosides are generally administered in cases of very severe or life-threatening infections, and to newborns who are in a state of sepsis. Ototoxic drugs cause hearing loss by affecting the cochlear hair cells and the stria vascularis. The outer hair cells are usually affected before the inner hair cells, and damage usually begins in the basal part of the cochlea. As a result, the hearing loss usually begins in the high frequencies and then proceeds to include successively lower frequencies. The hearing loss is usually bilateral but can be unilateral as well.

Since the child had developed SARS-Covid reactive antibodies, a rare case of bacterial meningitis, and was given ototoxic medication (in that order), the triad etiological factors might significantly influence the auditory system and lead to hearing loss in an interrelated manner. However, it is evident that hearing loss is a major complication in post-Meningitis and it is not surprising that the child has acquired hearing loss.

Conclusion

This study highlights the existence of multiple etiologies for bilateral profound sensory neural hearing loss in a child affected by bacterial meningitis caused due to a rare, nosocomial pathogen -*Elizabethkingia meningoseptica*.

Cochlear Implantation might be a rehabilitative option for the child but before deciding upon the candidacy, the child was put on a trial period with the hearing aid. The outcome measures may be observed through follow-up evaluation.

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