

Original Research Article

Evaluation and outcome of hearing in meningitis patients

Nandini Gupta^{1*}, Abhishek Khandelwal²

¹Department of ENT, BJMC, Ahmedabad, Gujarat, India

²Department of Pediatrics, BJMC, Ahmedabad, Gujarat, India

Received: 26 December 2023

Revised: 04 May 2024

Accepted: 06 May 2024

*Correspondence:

Dr. Nandini Gupta,

E-mail: guptanandini1823@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Meningitis remains the most common cause of acquired severe to profound SNHL in childhood. Likewise, deafness is the most common long-term neurological sequelae of the disease. Important consideration following meningitis is the development of labyrinthitis ossificans in which there is new bone formation within the lumen of the otic capsule. Ossification of the labyrinth can develop within a few days of meningitis which can make cochlear implantation difficult. Every newborn should be promptly screened for any hearing deficit along with the patients having meningitis. The most easily available investigation are OAE and BERA.

Methods: Our ambispective study of 25 patients was undertaken in a duration of 2 years in ENT department of civil hospital, Ahmedabad. All the patients underwent a detailed clinical examination and all routine audiological, and radiological investigations.

Results: The prevalence of hearing loss in post meningitis pediatric age group is 40%. Females are affected more than males. Median age group of presentation with hearing deficit is 4 years. Patients with complete immunization history have lower incidence of hearing loss associated with meningitis than incomplete immunization. Ossification of the cochlea can develop as early as 6 days from the development of first symptom.

Conclusions: Ossification of the cochlea can develop as early as 6 days from the development of first symptom. These are the candidates who should be prioritized for cochlear implant surgery. Patients with mild hearing loss recovered completely whereas those with profound hearing loss underwent cochlear implant surgery and were benefited with it.

Keywords: Meningitis, Labyrinthitis ossificans, Cochlear implant

INTRODUCTION

Meningitis remains the most common cause of acquired severe to profound SNHL in childhood. Likewise, deafness is the most common long-term neurological sequelae of the disease. Important consideration following meningitis is the development of labyrinthitis ossificans in which there is new bone formation within the lumen of the otic capsule.¹ Ossification of the labyrinth can develop within a few days of meningitis which can make cochlear implantation difficult. Of the various organisms causing bacterial meningitis, *S.*

pneumoniae is associated with more profound hearing loss. Various vaccinations against meningitis are available. These include the pneumococcal vaccine for *S. pneumoniae*, meningitis C vaccine for the serogroup C of *Neisseria meningitidis* and vaccination against *H. influenzae* type B. Quadrivalent vaccines effective against serogroups A, C, W-135 and Y of *N. meningitidis* are also available.² By protecting against mumps, measles and rubella, the MMR vaccine also protects against meningitis, which can arise as a complication of these diseases. Pneumococcal vaccines also have a role in the prevention of hearing loss arising due to otitis media: use of the 13-valent pneumococcal vaccine has been shown

to reduce the incidence of pneumococcal otitis media in childhood. Treatment of bacterial meningitis with appropriate antibiotics is essential. Broad-spectrum antibiotics should be given early and modified when bacteria are isolated and antibiotic sensitivities are determined. Ceftazidime is a first-line agent for the prevention of otogenic and meningogenic labyrinthitis because it reaches higher concentrations in the perilymph and cerebrospinal fluid (CSF) than other CSF-penetrating agents (eg, cefuroxime, cefotaxime).³ Evidence that administration of corticosteroids reduces the incidence of hearing loss in children and adults is accumulating. Maximal benefit occurs when the corticosteroids are given early in the course of meningitis. Several human and animal studies have demonstrated that steroid-induced immunosuppression may reduce hearing loss associated with bacterial meningitis.³ Every newborn should be promptly screened for any hearing deficit along with the patients having meningitis. The most easily available investigation is OAE which may indicate any hearing deficit if present. For further investigations, Evoked-response audiometry is sensitive in detecting SNHL and helpful in diagnosing hearing loss in young uncooperative children.⁴ Whereas temporal bone CT can show ossification related to meningitis well, MRI can provide complementary information when partial ossification has occurred. Early diagnosis of deafness after meningitis is therefore important. Thus it is important to prioritize patients with meningitis for cochlear implantation.⁵

Aims and objectives

Aim and objectives were; To determine the prevalence of hearing loss after an acute episode of meningitis in children, Interpretation of severity of hearing loss occurring in post meningitis patients, Determine incidence of labyrinthitis ossificans in post meningitis patients and Evaluation of outcome of hearing after intervention.

METHODS

Ambispective randomized controlled trial study of 25 patients was undertaken in ENT department of BJ Medical College and civil hospital, Ahmedabad in a duration of 2 years from November 2019 to October 2021.

Inclusion and exclusion criteria

Inclusion criteria was patients in 1 month to 6 years age group, patients with history of meningitis with positive CSF cultures (having total WBC count more than 10 cells per cummm). Exclusion criteria included patients with past history of trauma, patients with other CNS pathology, Complicated CSOM resulting in meningitis

All the patients underwent a detailed clinical examination along with the following investigations that included

audiological, radiological and routine investigations: Otoscopic examination, All routine blood investigations, OAE, Free field audiometry, BERA. Radiological investigations include high resolution computerised tomography HRCT scan of temporal bone and bony cochlea with MRI brain and CP angle, 7th and 8th cranial nerve complex with 3D reconstruction of cochlea.

RESULTS

Hearing impairment is a leading neurological consequence of bacterial meningitis, responsible for 60-90% of acquired post-lingual sensorineural hearing loss (SNHL) cases. When evaluating patients with SNHL, it is crucial to consider that the inner ear might be affected by either inflammation or neoplasm. These conditions can be challenging to differentiate on imaging, necessitating a thorough examination. In our study, the prevalence of hearing loss was 40%, compared to 30.4% in a study on pediatric hearing thresholds following bacterial meningitis. Similar prevalence rates, ranging from 22% to 44%, have been reported in several low- and middle-income countries.

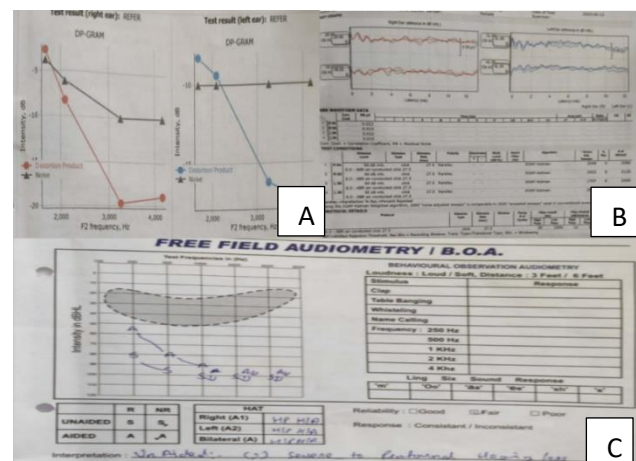


Figure 1: (A) OAE, (B) BERA and (C) FFA reports showing profound hearing loss.

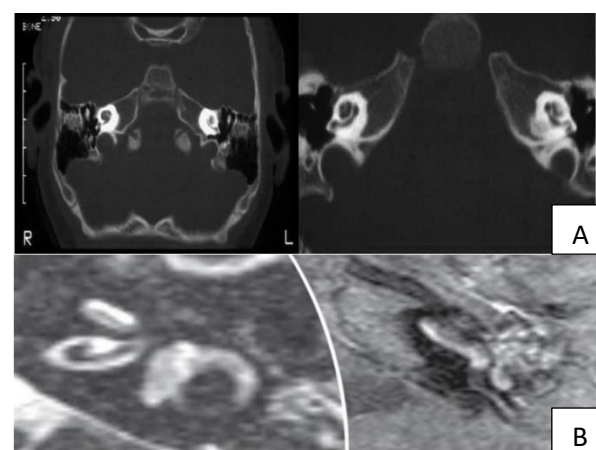


Figure 2: (A) HRCT and (B) MRI showing labyrinthitis ossificans.

In our study, the mean age of patients with hearing loss after meningitis is 4.3 years, and the median age is 4 years. These findings are similar to those in another study, which also reported a median age of 4 years among the cases. In our study, the male-to-female ratio of patients with hearing deficits after meningitis was 1:3. This disparity may be due to greater awareness and medical attention given to male children compared to female children in low socioeconomic classes in developing countries. In contrast, the other study reported almost equal numbers of males and females, with a male-to-female ratio of 1.2:1.

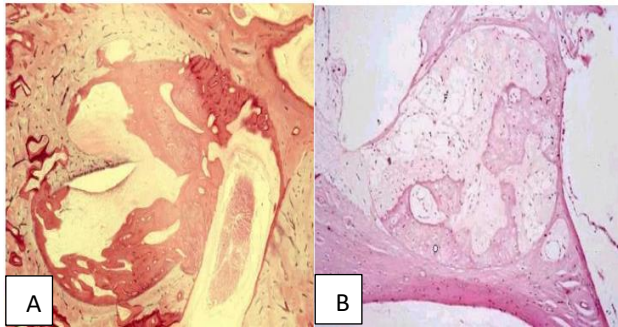


Figure 3: Fibrosis and ossification of the scala tympani are shown (A) fibrosis, (B) osteoneogenesis hematoxylin and eosin stain.

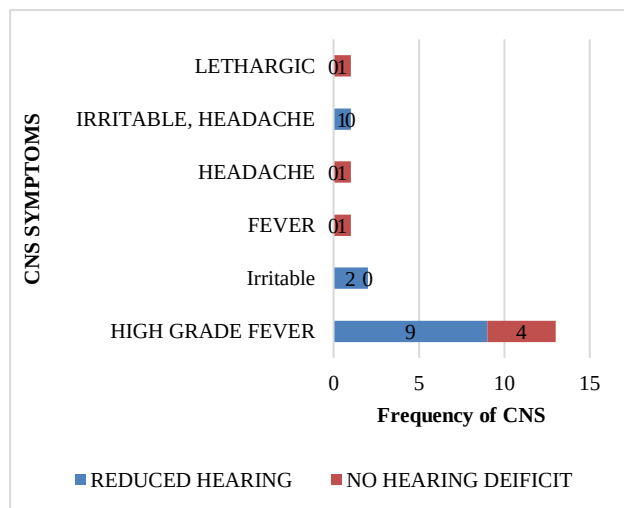


Figure 4: CNS symptoms.

There were more cases of bilateral hearing loss, likely due to the simultaneous involvement of both ears during the infection. Bilateral involvement may increase the likelihood of developing disabling hearing loss. In our study, we selected patients aged 1 month to 6 years with a past history of meningitis. Persistent SNHL was found in 40% of cases, while 20% experienced transient hearing loss (5 patients with mild reversible SNHL and 10 patients with profound SNHL). In contrast, a study reported by Dodge and colleagues found persistent SNHL in 10% of patients and transient conductive hearing loss in 16%. Our results showed a correlation between the

time from the first symptom to diagnosis and the development of labyrinthitis ossificans, with a mean of 8.3 days. This finding is supported by a study from 2004, which demonstrated osteoid deposition and mineralization occurring as early as 3 days post-infection and continuing for at least 28 days.

A retrospective study found that regardless of the cause of labyrinthitis ossificans, a distinct mineralization pattern was significantly more common in the basal turn of the cochlea. Similarly, in our study, 40% of patients had labyrinthitis ossificans, with 80% of these cases showing ossification in the basal turn of the cochlea. Additionally, another study reported that up to 80% of patients with profound postmeningitic deafness exhibit some degree of labyrinthine ossification in the basal turn.

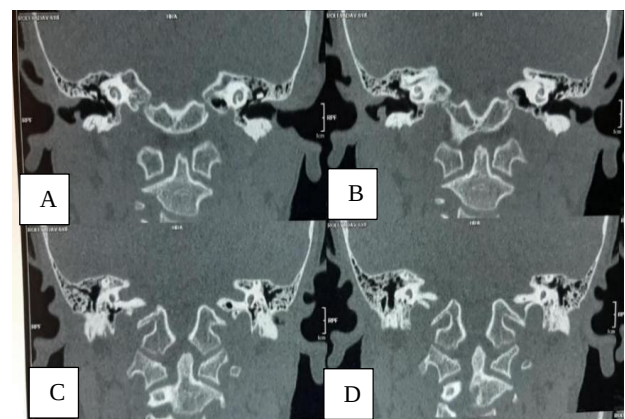


Figure 5 (A-D): HRCT temporal bone of cochlear labyrinthine ossificans.

Patients with mild hearing loss received prompt treatment with steroids and, if necessary, completed their vaccinations. They were also treated with antibiotics and provided with hearing aids for any residual hearing loss. During follow-up visits, new audiological investigations were conducted, and these patients showed no hearing deficit, achieving complete recovery.

Patients with profound hearing loss were followed up at 1, 3, 6, and 12 months after cochlear implant surgery, showing better audiological outcomes. They received appropriate speech therapy and timely mapping. Audiological improvement was evident, as the average CAP (categories of auditory performance) score improved from 0 preoperatively to 6 out of 7 postoperatively, and the SIR (speech intelligibility rating) score improved from 1 to 4 out of 5.

DISCUSSION

Hearing impairment is one of the leading neurological sequelae associated with bacterial meningitis, accounting for 60–90% of all cases of acquired post-lingual sensorineural hearing loss. In the evaluation of patients with sensorineural hearing loss, the inner ear may be

affected by inflammation or neoplasm. These pathologic entities can be difficult to discriminate on imaging, and careful examination must be undertaken.

The prevalence of hearing loss in our study is 40% whereas it was 30.4% among the cases in a study done on Pediatric Hearing Thresholds Post-bacterial Meningitis by Jatto et al as well as similar prevalence rates of 22-44% were reported from several LMICs. The mean age of the patients with hearing loss after meningitis in our study is 4.3, and the median is 4 and in the study done by Mercy et al results were similar to ours with a median age of 4 years among the cases.⁶ In my study, male to female ratio of patients with hearing deficit after meningitis was 1:3. This might be due to increased awareness more towards male child than a female child in low socioeconomic classes in developing countries. In a study done by Mercy et al, almost equal results were obtained having 57 males and 45 females, with a male-to-female ratio of 1.2:1. There were more cases of bilateral hearing loss, probably due to the simultaneous involvement of both ears during the infection.

The bilateral involvement may increase the likelihood of the development of disabling hearing loss. In my study, patients from age of 1 month to 6 years were selected with past history of meningitis with persistent SNHL in 40% with a transient hearing loss in 20% (5 patients having mild reversible SNHL and 10 patients having profound SNHL) whereas in a study conducted by Dodge and colleagues there was a persistent SNHL in 10% of patients and transient conductive hearing loss was found in 16%.⁷ Our results showed correlation between diagnosis from first symptom and patients developing labyrinthitis ossificans having a mean of 8.3 days which is supported by a study done by Tinling et al in 2004 who have shown osteoid deposition and mineralization occurring as early as 3 days postinfection and continuing at least through the first 28 days postinfection.⁸ A retrospective study by Buch et al found that no matter the cause of labyrinthitis ossificans, a distinct mineralization pattern was found significantly greater in the basal turn of the cochlea, same as in our study with 40% patients having labyrinthitis ossificans and out of that 80% patients having ossification in basal turn of cochlea.⁹ As many as 80% of patients with profound postmeningitic deafness have some degree of labyrinthine ossification in basal turn as found in a study done by Dodge et al.⁷ Patients with mild hearing loss underwent prompt treatment with steroids and complete vaccination if pending, along with antibiotics and using hearing aids for residual hearing loss. The patients were called in follow up and fresh audiological investigations were done. There was no hearing deficit in those patients and complete recovery was achieved. Patients with profound hearing loss were called for follow up at 1, 3, 6 and 12 months after cochlear implant surgery showing better audiological outcome. They were subjected to proper speech therapy and timely mapping. Patients have shown audiological improvement as the average CAP

(categories of auditory performance) score improved to 6 (out of a total score of 7) and SIR (speech intelligibility rating) score improved to 4 out of 5, post cochlear implant which was 0 and 1 preoperatively.

Limitations

There was a setback of attrition in a few patients due to lack of knowledge and due to patients living in rural areas, they were not facilitated with speech therapy.

CONCLUSION

The prevalence of hearing loss in post meningitis pediatric age group is 40%. Females are affected more than males. Median age group of presentation with hearing deficit is 4 years. Patients with complete immunization history have lower incidence of hearing loss associated with meningitis than incomplete immunization. Audiological screening by OAE and if required BERA, plays a major role in early diagnosis of auditory sequelae in meningitis. Patients with clinical and audiological hearing deficit have to undergo radiological imaging in form of HRCT and MRI for diagnosing ossification. Ossification of the cochlea can develop as early as 6 days from the development of first symptom. These are the candidates who should be prioritized for cochlear implant surgery. Patients with mild hearing loss recovered completely whereas those with profound hearing loss underwent cochlear implant surgery and were benefited with it.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Brown S. Otorhinolaryngology and Head and Neck Surgery. 8th ed. USA: Taylor and Francis; 2018.
2. Pace D, Pollard AJ. Meningococcal A, C, Y and W-135 polysaccharide-protein conjugate vaccines. *Arch Dis Child.* 2007;92(10):909-15.
3. Labyrinthitis Ossificans Treatment & Management. Available at: <https://emedicine.medscape.com/857018-treatment>. Accessed on 20 November 2023.
4. Sabo DL. The audiologic assessment of the young pediatric patient: the clinic. *Trends Amplif.* 1999;4(2):51-60.
5. Flint PW, Haughey BH, Robbins KT. Cummings Otolaryngology Head and Neck Surgery. 5th ed. USA: Elsevier; 2020.
6. Jatto ME, Adeyemo AA, Ogunkeyede SA, Lagunju IA, Nwaorgu OG. Pediatric Hearing Thresholds Post-bacterial Meningitis. *Front Surg.* 2020;7:36.
7. Dodge PR, Davis H, Feigin RD. Prospective evaluation of hearing impairment as a sequela of acute bacterial meningitis. *N Engl J Med.* 1984;311(14):869-74.

8. Tinling SP, Colton J, Brodie HA. Location and timing of initial osteoid deposition in postmeningitic labyrinthitis ossificans determined by multiple fluorescent labels. *Laryngoscope.* 2004;114(4):675-80.
9. Buch K, Bayliss B, Fujita A. Etiology-Specific Mineralization Patterns in Patients with Labyrinthitis Ossificans. *AJNR Am J Neuroradiol.* 2019;40(3):551-7.

Cite this article as: Gupta N, Khandelwal A. Evaluation and outcome of hearing in meningitis patients. *Int J Otorhinolaryngol Head Neck Surg* 2024;10:281-5.