HEARING EVALUATION IN CHILDREN WITH BACTERIAL MENINGITIS

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ABSTRACT

Twenty four children with bacterial meningitis were studied prospectively to ascertain the incidence, type and severity of hearing loss. The incidence of sensorineural hearing loss was 20.8%. Patients with hearing loss were followed-up audiologically for six months to find out the progress of hearing impairment. Of the five patients with sensorineural hearing loss only one showed partial recovery while the other three did not show any improvement. Of the five patients with sensorineural hearing loss only one showed partial recovery while the other three did not show any improvement. One patient was lost to follow-up, therefore, recovery was not known. The degree of hearing loss varied form mild to moderate.

Antibiotic treatment and laboratory data were analysed to identify the high risk factors predisposing to hearing impairment. The presence of low CSF sugar level, high protein at the initial lumbar puncture and presence of neurological deficits was associated with a significantly higher risk of hearing loss. However, the nature of antibiotic therapy, duration of illness, age and sex of the patients were not significant risk factors in the development of hearing impairment.

Key words: *Hearing loss, Bacterial meningitis, Auditory evaluation.*

Bacterial meningitis is often associated with considerable mortality and morbidity. The mortality in neonates varies from 15 - 50% whereas in older children it ranges from 1-6%(1). Amongst those who survive as many as 50% have some sequelae of the disease. Hearing impairment is one of the most damaging sequelae of bacterial meningitis which can be detected in 5-30% cases(1,2). This in turn affects the linguistic development(3). Therefore, an early diagnosis is imperative to undertake suitable remedial measures. Many children suffer temporary hearing loss that may be undetected even in a careful follow-up.

There are very few reports in the Indian literature on hearing impairment following bacterial meningitis(4,5). In order to determine the incidence, severity and type of hearing impairment in patients with bacterial meningitis and identify the risk factors thereof, we prospectively studied twenty four cases suffering from bacterial meningitis.

Material and Methods

The study was carried out in 24 children with bacterial meningitis, 6 months to 12 years of age admitted to the Pediatric ward from September, 1990 to February, 1991.

Children with history, clinical findings and CSF picture consistent with the diagnosis of bacterial meningitis were included in the

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study. Children with ASOM or history of CSOM, those who had received aminoglycosides or steroids prior to admission were excluded from the study as also those with a picture of partially treated pyogenic meningitis. The diagnosis of bacterial meningitis was based on the CSF examination including Gram staining, blood and CSF cultures. A turbid CSF with proteins >100 mg/dl, cell count >1000/cu mm, predominant polymorphonuclear leucocytes and sugar concentration <40 mg/dl was taken as strongly suggestive of bacterial meningitis(6). Cultures were done in all the cases but the overall positivity was low. The initial empirical therapy for bacterial meningitis entails selection of antibiotics that are effective against the likely etiological agents in a particular age group. Thus, children 6 months to 3 years of age received ampicillin (200-300 mg/kg/day) and chloromycetin (100 mg/kg/day) combination and those >3 years received Penicillin G (2-4 lac units/kg/day) and chloromycetin as is the routine practice in Pediatric ward. The average duration of treatment was two weeks (range 10-21 days).

Auditory functions were evaluated between tenth to fourteenth day of hospital admission to assess hearing impairment in each case. Pure tone audiometry was done with earphones in cooperative children and in the rest free field audiometry was performed(7). If any abnormality was detected, the tests were again carried out at monthly intervals for 6 months to find out any improvement. The hearing loss was classified into 6 groups(8): 10 to 25 db - normal hearing, 26 to 40 db - mild hearing loss, 41 to 55 db - moderate hearing loss, 56 to 70 db - moderately severe hearing loss, 71 to 90 db - severe hearing loss and >90 db - profound hearing loss. An improvement >15 db was labelled as partial recovery whereas full recovery occurred if the hearing loss at subsequent examination was <25 db. The results were tabulated and the clinical course of the illness was correlated with hearing loss.

The Student's 't' test and the Chi square test with Yate's correction were used to evaluate statistical significance.

Results

Twenty four cases of bacterial meningitis were evaluated. Four patients were less than 1 year, 8 patients between 1-5 years and 12 were more than 5 years of age. The male to female ratio was 1.4 : 1.0. The duration of symptoms before seeking admission varied from 1-30 days (mean 8 days). Three patients had received antibiotics prior to admission. CSF cultures were positive in only 3 cases, the overall positivity being 12.5%. Two cases in the age group <12 months showed the growth of hemolytic *Streptococcus* and one *E. coli*. None of these had hearing loss.

Of the twenty four patients studied, five had sensorineural hearing loss (20.8%) which was bilateral in all the cases. One patient showed partial recovery of hearing loss during follow-up whereas three did not have any recovery. One patient was lost to follow-up. The degree of hearing loss varied from mild to moderate.

Eight patients including 5 with sensorineural hearing loss showed CSF sugar levels of <20 mg/dl whereas the other 16 had levels of >20 mg/dl. A significantly greater proportion of low CSF sugar levels occurred among the hearing impaired group than among the normal hearing group ($p < 0.05$). The mean initial CSF protein concentration was higher among those with hearing loss as compared to the group with normal hearing (*Table I*) and the difference was significant ($p < 0.01$). The incidence of hearing loss was correlated with other serious neurological

sequelae including cranial nerve paralysis, hydrocephalus, persistent seizure activity and subdural effusion. The overall incidence of neurological sequelae among patients was 16.7%. The incidence of hearing loss among patients with neurological sequelae was 75% whereas among patients without neurological sequelae it was 20% (*Table I*). There was no significant correlation of initiation of appropriate therapy, age or sex of the patient with subsequent development of sensorineural hearing loss.

Fifteen patients received a combination of Penicillin and chloromycetin which included 2 with hearing loss. Six patients received ampicillin and chloromycetin including 2 with hearing loss. Cefotaxime was given to 3 patients of which one had hearing loss. The hearing impaired group and normal hearing group did not differ significantly in the antibiotic therapy.

Discussion

Evaluation of hearing loss in children suffering from meningitis with a view to establish cause and effect relationship is practically difficult. This is especially true during acute illness as subtle hearing loss may go undetected(9). Definite absence of past history of hearing impairment, behavioral observations and play audiometric tests for patients upto 4 years of age and pure tone threshold measurements in older children strongly point to the development of hearing loss following meningitis. Moreover, the incidence of congenital deafness is 1 in 1000 to 1 in 2000, an incidence of only 0.06%(10), therefore, it is unlikely that our 20.8% incidence of sensorineural hearing loss reflects a pre-existing impairment. Other studies have shown variable incidence of sensorineural hearing loss following bacterial meningitis ranging from 6 to 21%(9-12).

All the five patients with sensorineural hearing loss had bilateral involvement which has been observed in other studies also(11,13). The prognosis of hearing loss is variable. Some workers have not shown any improvement(10), whereas others have reported improvement(14) of sensorineural hearing loss. Recent studies(15,16) have established the beneficial effect of steroids in reducing the incidence of hearing loss by reducing the host inflammatory response mediated by cytokines to microbial products(17). How-

TABLE I—*Risk Factors Associated with Hearing Impairment*

Parameter	Hearing loss mean (SD)	No hearing loss mean (SD)	p value
Mean age (yr)	7.2(3.2)	5.4(4.0)	> 0.05
CSF cell count (cells/mm^3)	1977.0(277)	1985.1(237.6)	> 0.05
CSF sugar (mg/dl)	8.2(7.8)	37.6(18.6)	< 0.001
CSF protein (mg/dl)	384.0(55.9)	145.4(26.2)	< 0.01
Incidence of neurological sequelae	75%	20%	< 0.05
Interval between symptoms and therapy (days)	8.0(7.3)	8.8(10.6)	> 0.05

ever, the role of steroids was not evaluated in the present study.

The risk factors associated with hearing impairment included severely depressed CSF sugar levels and presence of neurological deficits. These findings are consistent with other studies(9-11,18). A high initial CSF protein concentration was also found to have significant correlation which has not been corroborated by other studies and needs further investigation. Antibiotic therapy had no relation to hearing loss though increased neurological and psychological sequelae have been reported in patients treated with combined ampicillin and chloromycetin or intravenous ampicillin alone(19,20). The incidence of hearing loss could not be correlated to pathogenic organisms as the culture positivity was low. Another multicenter study also shows the low incidence of 15.8% in our country for CSF culture positivity(21). The possible reasons are delayed and faulty inoculation, lack of CSF culture facility round the clock, non-availability of rapid diagnostic tests and patients having received antibiotics before admission(22).

Our study shows that hearing evaluation should be performed immediately after the episode of meningitis. If abnormal, it may need to be repeated at regular intervals thereafter. Prompt and proper auditory rehabilitation is necessary in young patients with hearing impairment for social adjustment and to prevent interference with linguistic development(8).

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REFERENCES

1. Kleigman RM, Feigin RD. Acute bacterial meningitis beyond the neonatal period. *In:* Nelson Textbook of Pediatrics, 14th edn, Ed Behrman RE. Philadelphia WB, Saunders Co, 1992, pp 683-690.
2. Snyder RD. Bacterial infections of the nervous system. *In:* Pediatric Neurology: Principles and Practice, 1st edn, Ed Swaiman KF. CV Mosby Co, Toronto, 1989, pp 458-459.
3. Tuli BS, Parmar TL, Kumar S. Incidence of deafness in school going children. Indian J Otolaryngol 1988, 40: 137-138.
4. Chaudhary R. A study of hearing and speech defects in post meningitic and post encephalitic children. MS Thesis (ENT), KGMC, Lucknow University, Lucknow, 1990.
5. Mathur NN, Kakar PK, Agarwal AK, Puri RK. Auditory pattern in deafness following meningococcal meningitis. Indian J Otolaryngol 1990, 42: 104-106.
6. Ghai OP, Kalra V. Acute bacterial meningitis. *In:* Essential Pediatrics, 2nd edn. Ed Ghai OP. New Delhi, Interprint, 1990, pp 299-302.
7. Chaturvedi VN, Chaturvedi P. Assessment of hearing in small children. Indian Pediatr 1980, 27: 827-831.
8. Pandit R. Rehabilitation of a deaf child. Indian J Pediatr 1992, 59: 367-370.
9. Nadol JB. Hearing loss as a sequelae of meningitis. Laryngoscope 1978, 88: 739-755.
10. Berlow SJ, Caldarelli DD, Matz GJ, Meyer DH, Harsch GG. Bacterial meningitis and sensorineural hearing loss: a prospective investigation. Laryngoscope 1980, 90: 1445-1452.
11. Keane WM, Potsic WP, Rowe LD, Konkle DF. Meningitis and hearing loss in children. Arch Otolaryngol 1979, 105: 39-44.
12. Dodge PR, Davis H, Feigin RD, *et al.*

Prospective evaluation of hearing loss as a sequelae of actue bacterial meningitis. N Engl J Med 1984, 311: 869-873.

13. Borkowski WJ Jr, Goldgar DE, Gorga MP, *et al.* Cerebrospinal fluid parameters and auditory brain stem responses following meningitis. Pediatr Neurol 1985, 1: 134-137.
14. Roeser RJ, Campbell JC, Dally DD. Recovery of auditory function following meningitic deafness. J Speech Hear Disord 1975, 40: 405-411.
15. Odio CM, Faingezicht I, Paris M, *et al.* The beneficial effect of early dexamethasone administration in infants and children with bacterial meningitis. N Engl J Med 1991, 324: 1525-1531.
16. Quagliarello V, Scheld WM. Bacterial meningitis: Pathogenesis, pathophysiology and progress. N Engl J Med 1992, 327: 864-872.
17. Finch RG, Mandragos C. Corticosteroids in bacterial meningitis. Br Med J 1991, 302: 607-608.
18. Kaplan SL, Cathin Fl, Weaver T, Feigin RD. Onset of hearing loss in children with bacterial meningitis. Pediatrics 1984, 73: 575-578.
19. Lindberg J. Long term outcome of *Hemophilus influenzae* meningitis related to antibiotic treatment. Pediatrics 1977, 60: 1-6.
20. Gamstrop I, Klockhoff H. Bilateral sensorineural hearing loss after Hemophilus influenzae meningitis in childhood. Neuropediatr 1974, 5: 121-124.
21. Kabra SK, Kumar P, Verma IC, *et al.* Bacterial meningitis in India: an IJP survey. Indian J Pediatr 1991, 58: 505-510.
22. Kalra V. Diagnostic tests for meningitis - a dilemma. Indian Pediatr 1989, 26: 1177-1180.