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RESEARCH ARTICLE

USE OF AUDITORY EVOKED POTENTIALS IN SCREENING CHILDREN FOR INTEGRITY OF AUDITORY PATHWAYS

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Background: Auditory evoked potentials (AEP) can be used to assess the integrity of auditory pathway for early hearing loss and planning rehabilitative procedures. It is noninvasive and can be performed in uncooperative and difficult-to-test children under mild sedation.
Aims and Objective: To determine the hearing threshold to assess the integrity of auditory pathway in children of suspected hearing loss and to find out the importance of AEP where other screening tests cannot be performed.
Materials and Methods: This retrospective study was conducted in Acharya Vinoba Bhave Rural Hospital and Department of Physiology, Jawaharlal Nehru Medical College, Sawangi (Meghe), Wardha, Maharashtra, India. It included 80 children of suspected hearing loss in the age group of 1–12 years, referred under Sarva Shiksha Abhiyan program. Brainstem auditory responses were recorded in these children using multichannel polyrite system. Silver chloride disk electrodes were used on standard scalp locations.
Results: Our results showed that 40 of 80 children were having definite mild-to-severe hearing loss. In nearly 50% children hearing loss was confirmed by AEP. In remaining 40 children, brainstem electric response audiometry showed normal responses indicating normal hearing. Of 80 suspected children, 20 were either uncooperative or not fit for any other screening tests for hearing. AEP showed that of these 20 children, 12 (15% of total), were having sensorineural loss that helped them in seeking treatment.
Conclusion: Our results concluded that AEP at present is one of the most useful tools for assessment of integrity of auditory pathway and detection of early hearing loss, and it can greatly contribute in its management. It can definitely be used in screening for deafness and assessing the nature of hearing loss, particularly in patients who cannot perform in the usual audiometric procedures. It can also be used to assess the maturity of central nervous system in newborn and young children.

INTRODUCTION

Auditory evoked potential (AEP) has been well documented as a method of screening deafness in very young children. The assessment of hearing is primarily a subjective test and no test other than a properly conducted pure tone audiometry test (carried out under ideal conditions) can tell us the exact hearing threshold level of the patient. However, not infrequently the neurotologists have to encounter a difficult-to-test patient (or a difficult-to-believe audiogram), and in such circumstances they have to depend on the objective tests to get a workable knowledge about the patients' hearing acuity. Of the objective tests available, the most common is AEP.[1] To assess the amount and nature of hearing loss and integrity of auditory pathway in the difficult-to-test patients, such as infants and subjects with mental retardation or suspected of malingering from whom requisite cooperation will not be available for foolproof subjective pure tone audiometry test, is one of the purposes of AEP.

AEP represents a noninvasive, simple, objective method for evaluating the function of the peripheral auditory apparatus in infants and children.[2] The brainstem potentials evoked by click stimuli can provide a reliable and objective assessment of auditory functions in congenital or early childhood onset hearing impairment that deprives the child of linguistic experiences.[3] AEP is an excellent complement to other audiological test methods, but it is not suitable for routine use at clinics where hearing of several children has to be tested every day.[4] It is definitely possible to operate a program of early detection of hearing loss in a general hospital, based on a high-risk register and AEP tests.[5] The generators of the vertex-positive peaks

have been related to sequential components of the auditory pathway. Laboratory and clinical evidence now suggest the following wave origins: (1) auditory nerve; (2) cochlear nucleus; (3) superior olivary complex; (4) midbrain, possibly nucleus of the lateral lemniscus; (5) inferior colliculus; (6) medial geniculate body; and (7) possibly auditory radiation from the thalamus to temporal cortex.[6] The normal AEP in adults show the characteristic seven waveforms, but in children usually only three waves (i.e., waves I, III, and V[6–9]) are recordable until auditory maturation. Waves of AEP primarily represent volume-conducted electrical activity generated from cochlear nerve to inferior colliculus, and interpeak latencies between three waves reflect neural conduction in the corresponding segment of central auditory pathways.[10] To prevent the acoustic crossover of the signals to the nontest ear, the use of contralateral masking is recommended in the monaural conditions.[11] This study aimed at diagnosis of deafness in children by determining the hearing threshold using AEP and to assess its use as a method of screening deafness in very young and difficult-to-test patients (e.g., patients with mental retardation and cerebral palsy). In Acharya Vinoba Bhave Rural Hospital, Sawangi (Meghe), Wardha, Maharashtra, India, the AEP is being used on children to determine the hearing thresholds, to objectively determine the nature of deafness, and to assess the maturity of central nervous system in newborn and young children.

MATERIALS AND METHODS

This retrospective observational study was conducted in neurophysiology department of 850-bedded tertiary-care hospital of Datta Meghe Institute of Medical Sciences University (NAAC re-accredited Grade A), Wardha, Maharashtra, India, from December 2008 to December 2010. Approval and clearance was obtained from institutional ethical committee.

Total 80 children (70% males and 30% females) were recruited. Mean age for selected participant group was 7.62 ± 2.39 years. All the patients were selected from OPD and IPD of ENT and pediatric departments for AEP assessment.

The participants were evaluated according to predesigned protocol, after their due consent and data were collected using structured interview information related to presence of ear diseases and other otological disorders. Each patient was examined once using an otoscope to verify the condition of external ear for AEP assessment. AEP assessment was done using multichannel polyrite system. Silver chloride disk electrodes were used on standard scalp locations.[12]

Inclusion and Exclusion Criteria: Patients with supportive ear disease such as ASOM or CSOM, systemic disease, or any history of use of ototoxic drugs were excluded from the study. Patients referred from various departments with age group shown in Table 1 were included in the study on random selection basis.

Table 1: Age and sex distribution of children referred for AEP

Age Group (years)	Number of Participants	Sex	Number of Participants
1–5	21 (26.2%)	Male	56 (70%)
6–12	59 (73.7%)	Female	24 (30%)
Total	80	Total	80

Table 2: Indications for Referral to Perform AEP

a) Audiology unit	**Total 16**
1) After PTA test screening—For confirmation	12
2) For selection of hearing aids	4
b) Pediatricians	**Total 40**
1) Delayed milestones	22
2) Speech disorders and mental retardation	18
c) ENT surgeon	**Total 24**
1) Suspicious hearing impairment	20
2) Integrity of auditory pathway	2
3) For clinical correlation	2

Recording of Auditory Evoked Potentials: Evoked potentials were recorded after sedating the apprehensive patients with oral triclofos syrup, and testing them in quiet and relaxed test environment.[13] Auditory brainstem response recordings by monaural presentation were obtained first by following test protocol given by Hall.[14] A total of 2000 stimulations were averaged and all the parameters were compared at 70-dB stimulus intensity level. Other technical specifications were kept constant for both recordings. Masking with white noise was given in nontest ear for monaural recordings.[15]

The main sources of referral of these children to the Department of Physiology were from Sarva Shiksha Abhiyan program, under which such children were first assessed by the peripheral medical officers at the rural area to determine hearing loss on free-field assessment. Children suspected of hearing impairment or definite hearing loss were then seen by the ENT surgeon and then were sent for AEP. Some cases were also referred by the pediatricians and audiologists of our hospital.

The indications for assessment of hearing in these children by brainstem electric response audiometry are given in Table 2.

RESULTS

Our results showed that 40 of 80 children had definite mild-to-severe hearing loss. In these 80 children of suspected hearing loss, it was difficult on free-field assessment to prove with certainty if there was any hearing impairment, but AEP confirmed the hearing loss in 40 (50%) children. In at least 20 of these 40 children, before AEP it was difficult to even say whether there was any hearing impairment because of severe handicap. In this survey, in these 20 cases (25%), there was no other means of determining the hearing acuity. Of these 20 children, AEP showed beyond doubt a mild hearing loss in 8 and moderate or severe loss in 12, which ultimately led them, being fitted with hearing aids. These 12 cases represent 15% of total 80 cases of suspected loss, and hence we feel AEP is of great significance in the management of children with hearing loss. Of 80 children, 17 (21.2%) were found to have normal hearing as AEP showed normal responses. In 40 (50%) cases, the AEP agreed and confirmed a mild-to-severe sensorineural loss. Moreover, it helped 12 (15%) uncooperative and difficult-to-test children (e.g., children with mental retardation and infants in whom other screening tests were not possible) by showing moderate-to-severe hearing loss, which helped them in seeking treatment.

DISCUSSION

AEP responses (particularly the absolute and interpeak latencies) represent a series of potentials corresponding to sequential activation of the peripheral (acoustic nerve and pontomedullary portion) and central (pontine and midbrain) portions. Normative data for various parameters of AEP such as absolute latency, interpeak latency, amplitude ratios, and hearing thresholds were first established.[16] Prolongation of absolute latencies and interpeak latencies are indicative of delayed conduction in brainstem auditory pathway.[17,18] AEP is very useful in early detection of hearing loss and planning rehabilitative procedures. In case of multiple handicaps, it is the only test that can give accurate picture of hearing sensitivity. In cases of high-risk babies, AEP should be carried out as a routine procedure to detect hearing loss. These tests help us to conclude the cause of delay in speech and language development. It is the only tool that can confirm the normal sensitivity of hearing whenever required.

In 80 cases where the free-field assessment had shown a suspected hearing loss and AEP was requested to confirm and assess accurately the hearing impairment, AEP confirmed the hearing loss in 40 children. We found that 26.2% of referred children belong to age group of 1–5 years whereas 73.7% belong to 6–12 years. This shows that the early referral was poor. However in spite of delay in referrals these children may still be benefitted by rehabilitative measures without which they are at risk for a significant delay in receptive and expressive skills. A further research is required with elaborated sample size to specify methods to quantify their yield as components of early assessment programs and to assess the clinical significance of various patterns of abnormality in relation to risk factors, developmental sequelae, and differential management decisions.[12] It appears that AEP is at present the most useful audiometric tool for early hearing evaluation and can contribute a great deal for early hearing loss detection and management.

In our experience, AEP has been proved to be useful in determination of hearing threshold in children with suspected hearing loss. The assessment of hearing level in children with severe disability or mental retardation is not possible by any other means. One would not advocate that AEP is the most important single investigation in all cases of suspected hearing loss, but it definitely improves the degree of certainty in diagnosis and assessing deafness in such children. It can also be used in assessing the hearing threshold and maturity of central nervous system in children below the age of 5 years, especially in those between 1 and 5 years. We have found that AEP has been a valuable and reliable diagnostic tool in management of children with hearing loss if its limitations and the parameters used are taken into account when interpreting its findings. Moreover, awareness among the peripheral health practitioners about the potentials of AEP in early diagnosis of hearing loss should be encouraged.

Limitations: (1) Study comprised of child population only. (2) Only bilateral symmetrical moderate hearing loss was studied.

CONCLUSION

Our results conclude that AEP is at present one of the most useful tools for assessment of integrity of auditory pathway and detection of early hearing loss, and it can contribute greatly in its management. It can definitely be used in screening for deafness and assessing the nature of hearing loss particularly in patients who cannot perform in the usual audiometric procedures. It can also be used to assess the maturity of central nervous system in newborn and young children.

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