Screening of hearing in delayed speech development by auditory brain stem response (A useful sorting test)

Awad Al-Serhani, MD, Mohammad Kabiraj, MD, Hamad Al-Muhaimid, MD, Abdulrahman Al-Essa, MD, Seraj Zakzouk, FRCS.

ABSTRACT
Objective: To study the role of auditory brain stem response (ABR) in sorting children with delayed speech development (DSD) according to their hearing threshold (HT). Further steps in evaluation or management could be followed accordingly. Materials: A retrospective analysis of ABR results in 130 children with DSD. Age ranged between 16 months and 6 years (mean age 4.6). They were referred from Riyadh area and other provinces for estimation of hearing level by ABR as a part of their evaluation. Results: Three groups were identified: i. Thirty seven children (28.8%) had adequate HT to develop normal speech (27 had normal HT and 10 had only unilateral affection). ii. Twenty five children (19.2%) had mild hearing loss (19 had sensorineural type and 6 conductive type). iii. Sixty eight children (52.3%) had severe hearing loss (39 children) and profound hearing loss (29 children). Conclusion: ABR is a useful test in sorting patients with DSD to fit them in the suitable program of evaluation or rehabilitation. Public education as well as medical and paramedical awareness of the problem may prevent such late presentation. Management of these children in multidisciplinary centers throughout the main provinces will be more ideal and yielding.

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Delayed speech/language development (DSD) in children is a distressing problem for parents, and on many occasions, is not an easy task for those involved in its management. Although speech acquisition age varies in children and some with possible delay in their early life may grow out of it, any suspicion should be taken seriously and investigated immediately rather than reassuring the parents and delaying habilitation. The emergence of speech in the normal child serves as an excellent index of his physical, intellectual and emotional status. Speech development is linked to sensory input and motor development in step with growth of the brain and intelligence. Considering the multifactorial causation of DSD, hearing deficit is probably the most important especially to the otorhinolaryngologist and audiologist who should make all efforts to detect and help as early as possible. Numerous techniques have been tried to evaluate the auditory function in the newborn, infants and children including pure tone audiometry, behavioral tests, impedance audiometry and recently otoacoustic emission. Although all are helpful in different situations, ABR seems to be collectively the best. Evoked response audiometry (ERA) is performed by recording potentials arising in the auditory system in response to auditory stimulus. They are divided into: electrocochleography, ABR and auditory cortical responses (middle and late latencies). Tone pips, bursts or filtered clicks can be used to have frequency specificity but they need special masking techniques and are time consuming. The test of ABR is non invasive, evaluates the pathway until midbrain and is not affected by anesthesia or sedation. Moreover, the test can predict the level of the lesion on the auditory pathway and the hearing threshold and suggests suitable hearing aids for habilitation. It should be stressed here, however, that with click stimuli low frequencies may be underestimated and it is suggested to use impedance audiometry or SN10 (after frequency negative wave) for better fitting of hearing aid. Alternatively, filtered noise or high pass noise can be used to select the tested frequencies. It should be remembered also that it does not evaluate the hearing function but rather HT on the subcortical level, eg. patient may have normal HT

From the Departments of Otorhinolaryngology (Al-Serhani, Al-Muhaimid Al-Essa, Zakzouk) and Clinical Physiology (Kabiraj), King Abdulaziz University Hospital, Riyadh.

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Address Correspondence and reprint request to: Dr. Awad Al-Serhani, Department of Otorhinolaryngology, King Abdulaziz University Hospital, PO Box 245, Riyadh 11411, Kingdom of Saudi Arabia.
but no cognition function.\textsuperscript{3} For such a defect, middle and late latencies can be helpful,\textsuperscript{6} although they can be affected by the mental status of the patient; anesthesia and sedation reducing markedly their reliability.

**Materials and methods.** The results of ABR in 130 patients seen over a 5 year period (1988-1993) at King Abdul Aziz University Hospital (KAUH), Riyadh were analyzed. These children were referred either from Primary Health Care Clinics in Riyadh or form health centers in rural areas, for ABR, as a part of their evaluation for suspicion or presence of delayed speech development. The sample consisted of 84 males and 46 females, the age of which ranged between 16 months and 6 years (mean age 4.6 yrs.). Unfortunately, relevant clinical information is lacking due to the referral system (patients come mostly from outside Riyadh and the ABR results are forwarded to their referring institute for further steps). The test was carried out under chloral hydrate sedation in all cases. Averaged clicks were used for stimulation and vertex to ipsilateral ear lobule derivation was used for recording. The response threshold, waves amplitude, absolute peak latencies for waves I, III and V, as well as interpeak latencies I-II, III-V, and latency intensity curve for wave V at 80 dB, 60 dB 40 dB and 20 dB were used for interpretation. The results were analyzed and compared with our laboratory standard. For discussion purposes they have been grouped according to HT and the probability of speech development affection into 3 groups (Fig.1).

**Results.** The analysis of ABR results of 130 patients could identify 3 groups:

- **Group A:** Thirty seven patients (28.5\%) who had no obvious peripheral hearing defect capable of causing DSD. Twenty seven patients had normal HT bilaterally while the remaining 10 patients had unilateral affection with normal HT on the other side.

- **Group B:** Twenty five patients (19.2\%) had hearing levels that can contribute to defected speech. Nineteen of them had mild HL with HT of about 40dB or less. The other 6 patients had conductive HL in the similar range.

- **Group C:** Sixty eight patients (52.3\%) had HL severe enough to cause DSD. Thirty nine of them had severe SNHL (HT 60-90), 17 of which had cochlear type, 2 had retrocochlear and 20 were undetermined. The other 29 patients had profound SNHL.

All three groups required further evaluation by the other disciplines which could have been better in one center for the benefit of the patients and community.

**Discussion.** Delayed speech development can be caused by several disorders including hearing impairment. mental handicap, autism, severe social deprivation or specific speech and language disorders.\textsuperscript{1,2,3} Since ABR was described in 1970 it has been in expanded use, as an objective test for HT in children, uncooperative patients and malingerers, as well as to localize lesions in the auditory pathway and brain stem.\textsuperscript{4} Recently, it has been used to screen NICU infants at risk of HL. By utilizing ABR, the habilitation program for deaf children can be started early; suitable hearing aids may be fitted, and selected candidates may be evaluated for cochlear implant.\textsuperscript{7}

Our study identified 3 major categories of hearing levels. In the first group of 37 patients, 27 had normal HT and 10 had only unilateral affection excluding peripheral hearing deficit as a cause of their DSD. However, ABR is a subcortical test that does not evaluate the cognition of this group. Middle and late cortical responses can be of value for cortical auditory lesions although its reliability is poor and is affected by factors such as sleep stage, sedation and anesthesia.\textsuperscript{3,6} Excluding non apparent neurological lesions by neurology assessment, autism and social deprivation by a psychologist are important. Some of them were below 2 years of age and may still develop normally. This reflects the importance of both the availability of centers with a multi-disciplinary team for evaluation, management and follow up. the second category consisted of 25

![Figure 1 - Histogram showing distribution of the patients with delayed speech, according to their ABR abnormalities. Note that ABR indicating sensorineural hearing loss (including no response group) constitute the majority of the patients. 1. Group I - Normal ABR, Unilateral HL. 2. Group II - Mild SNHL, Conductive HL. 3. Group III - Severe SNHL, Profound SNHL.](image-url)
patients 19 of whom had mild SNLH and 6 had conductive HL (HT 40dB) which may play a role in defective speech, although it is unlikely to cause DSD on its own. As low frequencies are missed by click stimuli, tone bursts stimuli using different frequencies, high pass noise making, behavioral tests or PTA in older children may help in clarifying HT in these frequencies. The possible causes of DSD mentioned in the first category are still to be considered. The third category consisted of 68 children, 39 of whom had severe SNHL (HT 60-90dB) and 29 profound SNHL with no response at 95dB. In this group, DSD can be explained by such degree of hearing loss. This category along with their evaluation by the team involved with the DSD patient, needs particular habilitation. They should be fitted with hearing aids as early as possible if hearing remnants are to be utilized, or cochlear implant in the profoundly deaf patients who fit the selection criteria. However, HT as evaluated by ABR can be misleading especially in sloping hearing loss where different frequencies are not equally affected. In such patients either frequency specific stimuli for ABR (as in high-pass noise technique), or acoustic reflex audiometry in low frequencies and ABR in high frequencies should be used to predict HT to a better degree of accuracy and hence, the patients can be fitted with the proper line of management and habilitation as described above. Two patients of this group had retrocochlear lesion. Such a finding gives poor discrimination if a hearing aid is fitted and alerts the otolaryngologist to exclude the possibility of cochlear implant if they progress to profound SNHL. This is an advantage of ABR that localizes the lesion, although not enough alone especially with click stimuli. These children should have a speech habilitation program as soon as their hearing impairment is assisted. Other causes of DSD such as autism and social deprivation should be considered even in the presence of hearing loss as they may coincide as previously reported.

If we add the mild hearing loss in 19 patients as well as the conductive hearing loss in 6 patients to the 68 patients with severe to profound SNHL then 95 patients (71.5%) could have hearing loss as the contributing/cause for DSD. This strengthens the role of ABR in detecting early any hearing defect and helping the further evaluation or habilitation of these patients. This high percentage (71.5%) reflects also the role of hearing loss in DSD in our community where consanguineous marriage is common.

Our results show the importance of team work in the evaluation and management of children with DSD. This is reflected by the need to further evaluate those patients who did not show enough hearing loss for the possibility of neurological lesions, autism and psychomotor development and to habilitate the others with obvious hearing loss, along with evaluation for other causes.

These patients were sent to us for evaluation of their hearing by ABR and one can imagine different approaches by the referring person to the problem according to his standard, facilities and the understanding of the problem both by the community and the health personnel. This indicates the importance of a team approach to the problem in a combined clinic which includes an otolaryngologist, pediatric neurologist, speech pathologist, audiologist and psychologist whose proper integrated evaluation of the problem is needed. It will also help to facilitate the evaluation of the size of such a national problem and plan for prevention and management. This can preferably be conducted in centers scattered over the main country provinces to facilitate patients compliance and easy communication as well as to reduce and utilize the cost. We observed that most of the patients are sent late for ABR as the mean age was 4.6 years indication the role of the pediatricians to evaluate those at risk during their early infancy, the role of family health care personnel to early detect and investigate any suspicious infant/child, and the role of community education to alert parents of such a problem and the consequences of the delay in its management. Lastly, community based studies to detect the size of the problem and the aetiology, especially the genetic predisposition in our community with common consanguineous marriage, is strongly recommended.

References