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AUDITORY EVALUATION OF THE MICROCEPHALIC CHILDREN WITH BRAIN STEM EVOKED RESPONSE AUDIOMETRY (BERA)

PIYALI DAS[1], MANIMAY BANDYOPADHYAY[2], BALAJI W. GHUGARE[3], JAYSHREE GHATE[4] AND RAMJI SINGH[4]

Departments of [1]Physiology & [2]Anatomy, National Medical College, Kolkata – 700019;
[3]Department of Physiology, SVNGMCH, Yestmal – 445001 and
[4]Department of Physiology, Mahtma Gandhi Institute of Medical Sciences, Sevagram, Wardha – 442 102

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Abstract : Microcephaly implies a reduced occipito-frontal circumference (< 2 Standard Deviation of normal) and therefore a small brain size, which is usually associated with different neurodeficit. Intactness of the auditory pathway in microcephalic as well as normal children was assessed by Brain stem Evoked Response Audiometry (BERA) to locate the exact site of lesion resulting in the auditory impairment, so that appropriate early rehabilitative measures can be taken. The study revealed that absolute peak latency of wave V, inter peak latencies of III–V and I–V were significantly higher (P- value <0.05 in each case) in microcephalics than the normal children. Auditory impairment in microcephaly is a common neurodeficit that can be authentically assessed by BERA. The hearing impairment in microcephalics is mostly due to insufficiency of central components of auditory pathway at the level of brainstem, function of peripheral structures being almost within normal limit.

Key words : microcephaly BERA auditory evaluation

INTRODUCTION

Microcephaly denotes a structural anomaly of head where occipito- frontal circumference (OFC) of a subject falls below the mean head circumference of that specific age and gender by two or more standard deviations (SD) (1). Microcephaly implies a small brain size and warns the resultant neurological impairment. Hearing impairment is one of the major clinical presentations in microcephalics as evidenced by American Academy of Neurology (2). So it is pertinent to assess the neuronal integrity in the auditory path way among the microcephalics not only to have an idea about the extent of neurodeficit but also to institute rehabilitative measures for those children at the earliest. Brain stem Evoked Response Audiometry (BERA) is an objective electro

*Corresponding Author : Dr. Ramji Singh, Prof. and Head, Department of Physiology, Mahatma Gandhi Institute of Medical Sciences, Sevagram, Wardha – 442 102; E-mail : sramji57@gmail.com; Phone No. 09423421794; Fax No. 07152-84333

diagnostic test for the assessment of neuronal integrity in the auditory path way, which is especially important in young children where patient's cooperation often remains at a minimum. BERA is a non-invasive technique where a series of potentials are generated corresponding to a sequential activation of different parts of the auditory pathway starting from the peripheral part (cochlear nerve) up to the brainstem (inferior colliculus) within 10 millisecond after acoustic stimulus (3).

Thereby BERA recording not only evaluates the functional integrity of sub cortical auditory pathway, but also suggests about the probable site of lesion. In our present study, BERA was done in a group of microcephalic and age-sex matched normal children to compare the intactness of the auditory pathway which may be an important component of overall diagnostic work-up in subjects with microcephaly.

MATERIALS AND METHODS

Study was conducted at the Neurophysiology unit of the Dept. of Physiology, MGIMS, Sevagram on 12 children with microcephaly and 20 age sex matched otherwise healthy children with normal occipito frontal circumference and without any clinical neurodeficit. All the examinations (both Physical and electro diagnostic) were done with informed consent from the legal guardians of the subjects and as per the permission of Institutional Ethics Committee. Relevant history was taken and clinical examination was done according to structured format.

Exclusion criteria : Subjects with any associated cause of neurodeficit (birth trauma, cerebral palsy, exposure to any CNS depressant etc.) were excluded from the study.

Recording of brain stem evoked response audiometry

After selecting the subjects (through proper history and clinical examination), they were subjected to BERA testing according to standard techniques (4) on RMS EMG EP MARK-II machine manufactured by RMS RECORDERS and MEDICARE SYSTEM, Chandigarh. The data was stored for statistical analysis.

Procedure in brief

Recording of BERA was carried out in a quiet and dimly lit room with subject in supine position. Restless and irritable children were given oral promethazine (0.5 mg/kg body weight) for sedation before testing. Surface electrodes were placed at the vertex (Cz), both ear lobes (Ai and Ac) and forehead (ground). Monoaural auditory stimulus consisting of rarefaction clicks of 100 μ second square pulse were delivered through an electrically shielded earphone at a rate of 11.1/second. Contralateral ear was masked with pure white noise 40 deci Bell (dB) below that of the BERA stimulus. A band pass of 10–3000 Hz was used to filter out undesirable frequencies in the surrounding. Responses to 4000 click presentations were averaged for 10 milli second (msec). Waveforms obtained at 60 dB above the sensation threshold for that ear were recorded for analysis.

Parameters studied

BERA threshold for each ear with absolute peak latencies of waves I, III, V, inter peak latencies of I–III, III–V, I–V wave forms and V:I ratio were considered from the recording for the comparison among microcephalic and age-sex matched normal children.

Statistical calculation

Significance of difference in the mean values of different parameters in the two groups was assessed by Student's "t" test and the P-value < 0.05 was considered to be significant. All the values were expressed as means±1 SD. Calculations were done using STATA-10 and Microsoft Excel soft ware.

RESULTS

Total 32 subjects were investigated, among which 12 were microcephalic and 20 were healthy control. Ages of the subjects were in a range of 6 months to 6years. The physical parameters [age of presentation, weight, height, Body Mass Index (BMI)] of normal as well as microcephalic children are depicted in Table I. The findings of BERA recording (as mean±1 SD) are tabulated in Table II.

Among all these latency values, absolute peak latency of wave V, inter peak latencies of III–V and I–V were found to be significantly lower in normal group than microcephalics (P- value <0.05 in each case). Average amplitude ratio of V: I though not statistically significant (P- value >0.05), was found to be lower in microcephalics than their normal counterpart (Figs. 1 and 2).

TABLE II: Mean values of the BERA parameters in microcephalics and their age gender matched controls.

Sl. No.	*Parameter studied*	*Microcephalics*	*Control*
1.	Average BERA threshold	54±17.76* dB	31±3.16 dB
2.	Absolute peak latencies for wave V	6.14±0.75* msec	5.1±0.25 msec
3.	Absolute peak latencies for wave I	2.02±0.64* msec	1.6±0.15 msec
4.	Absolute peak latencies for wave III	4.2±0.6* msec	3.59±0.24 msec
5.	Inter peak latencies for I–III	2.19±0.59* msec	1.97±0.19 msec
6.	Inter peak latencies for III–V	1.88±0.21* msec	1.55±0.18 msec
7.	Inter peak latencies of I–V	4.07±0.76* msec	3.5±0.2 msec
8.	V: I ratio	1.69±0.19	2.35±1.6

*P<0.05, compared with control.

TABLE I: Physical parameters in normal and microcephalics. Values are Mean±SD.

Group of children	*Age of presentation (in years)*	*Body weight (in kg)*	*Height (in cm)*	*BMI (wt in kg/height in meter^2)*
Control	3.15±2.48	13.58±5.67	84.12±17.26	18.68±2.1
Microcephalic	2.88±2.16	7.92±5.15	72.5±19.97	12.81±1.87

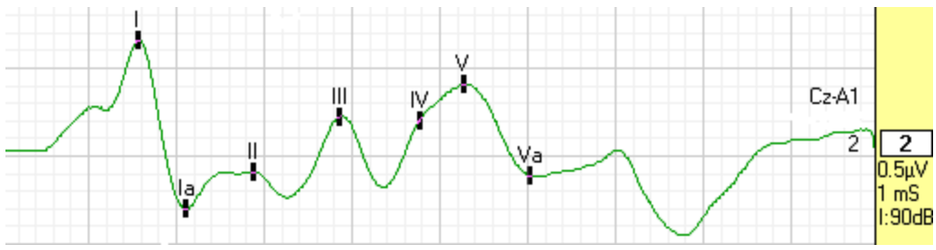

Fig. 1: Tracing showing BERA recording of a normal healthy child of 4 years.

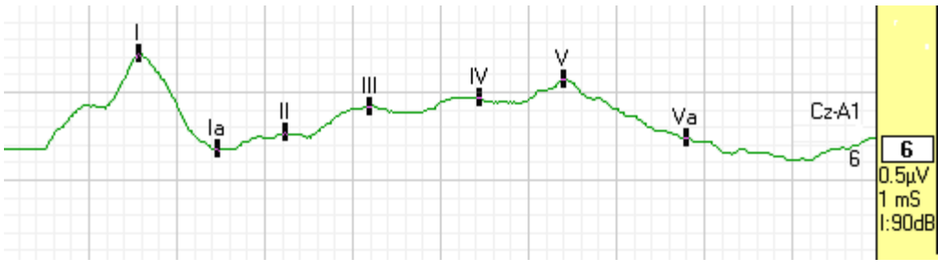

Fig. 2: Tracing showing BERA recording of a microcephalic child of 4 years.

DISCUSSION

Microcephaly is a common developmental defect that can have either prenatal or postnatal onset. It is anatomically, clinically and etiologically a heterogeneous disorder. Helmers S suggested that it may have large spectrum of presentations, inheritance pattern, life span expectancy, degree of psychomotor abnormalities and variety of associated anomalies including various inborn errors of metabolism (4). According to him it may present with normal cerebral cortical thickness, normal or mildly disrupted gyral pattern, mild developmental delay and moderate mental retardations (as in case of microcephaly vera) (4). At the other end of the spectrum Amish lethal microcephaly presents with extreme degree of small size of the brain (<6 SD of normal). Affected children are unresponsive to light and sound as per the finding of Rajab A et al (6).

However, irrespective of the etiological background overall pathological processes involved in microcephaly are defective neuronal proliferation, differentiation or excess neuronal death in the developing brain. There by, an overall small sized brain may lack different neuronal circuitry and thus may be associated with agenesis of optic pathway, absence of auditory pathway, absence of pars compacta of substantia nigra, hypoplasia of the cerebellum and its connections etc as per the opinion of Fabian VA et al (7). In our present study significantly higher threshold for BERA along with prolonged absolute latency of wave V in microcephalics than their age sex matched normal counterparts indicate developemental anomaly in the auditory path way especially in the region of brain stem in the first group.

As the origin of wave IV and V are from the lateral lemniscus of upper pons and inferior colliculi of the midbrain respectively, these components of BERA are the earliest to be absent in the patients with lesions of the mid pons, rostral pons and mesencephalon as opined by Legatt AD (8).

Significantly prolonged interpeak latencies of III–V and I–V in the microcephalics in the present study further suggest maturational delay in the central components of auditory path way. Most peripheral structures of auditory tract are well myelinated with complete anatomic and physiologic maturation by the first few weeks of birth where as myelination and synaptogenesis of the central auditory component begin between 26 to 30 weeks. Therefore, developmental failure of central auditory components due to any etiological background during that period may be associated with fully developed peripheral auditory structures as per Mishra UK et al (3).

Comparatively unaffected absolute latency of wave I and interpeak latency of I-III (associated with auditory pathway from acoustic nerve to superior olivary complex of pons) supports the peripheral to central maturational pattern of auditory tract. Lower V:I amplitude ratio in microcephalics, though not statistically significant (may be due to smaller sample size), highlights further that, developmental failure of central auditory neurons is the most likely cause of hearing impairment in microcephalics. This corroborates the findings of Mangunatmadja I et al, 2003 (1). Therefore, present study points towards the fact that in microcephaly auditory impairment is a common neurodeficit that may be objectively assessed by BERA and the most probable cause is deficiency of the central auditory component in the region of the brain stem. Thus, BERA seems to be an authentic tool for the auditory evaluation in microcephalics which can help the clinicians to plan proper rehabilitative measures to tackle related handicap at an early stage.

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