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BERA as a screerning tool for evaluating cases of SNHL due to suspected retrocochlear pathology

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Abstract
Background: BERA is an objective study for assessing hearing loss on patients with inconsistent responses on pure tone audiogram. BERA is a non-invasive and the most cost-effective method for diagnosing retrocochlear lesion, not affected by sedation, anesthesia or age. Which helps to identify retrocochlear hearing loss. BERA is most accurate and sensitive for diagnosis of lesions in VIII nerve and auditory pathway in brainstem, especially in adults.
Objectives: Screening tool for evaluating cases of sensorineural hearing loss due to suspected retrocochlear pathology. Objective test in cases of inconsistent response for pure tone audiometry. Role in evaluating brainstem lesions.
Method and Aim: This is a cross sectional prospective cohortHospital based study, review of 50 patient subjected to BERA for SNHL in any age group referred to department of ENT Vijayanagara institute of medical sciences, Bellary. We aim to find Brainstem evoked response audiometry (BERA) andits applications in ENT.
Result: In this study threshold and latency measures were obtained from 50 cases (100 ears) by brainstem evoked response audiometry. No restrictions were imposed on age, sex, degree of hearing loss, or audiometric configuration. The data was analyzed separately for pediatric age group (36 cases) and adults(16 cases). out of 36 pediatric cases screened 15 cases (41.7%) had normal hearing in 13 cases had profound hearing loss without any risk factors. 6 cases (16.7 %) hearing loss due meningitis. 2 cases (5.6%) hearing loss due to neonatal jaundice. In adult age group (14 cases) BERA was done to identify cases of retocochlear pathology and in cases of threshold estimation of hearing.
Conclusion: BERA can be used to screen retrocochlear pathologies as seen in our study. Patients with hearing loss with tinnitus and giddiness screened and BERA performed had grossly degraded wave with identification of only wave I and absence of other waves and increased latencies and interaural difference in wave latencies suggests lesion in the auditory pathway. Depending on the absence of specific wave site of the lesion can also be made out. In our study 3 cases of retrocochlear pathology previously confirmed by MRI was taken and BERA was performed showing presence of only wave I and absence of remaining waves. BERA is screening test and should be confirmed by MRI.

Keywords: BERA, retrocochlear hearing loss, absolute latency

Introduction

BERA is an electrophysiological test procedure which studies the electrical potential generated at various levels of auditory system starting from cochlea to cortex.

There are a few pure tone and impedance audiometric tests designed to differentiate between cochlear and retrocochlear hearing loss, BERA is most accurate and sensitive for diagnosis of lesions in VIII nerve and auditory pathway in brainstem, especially in adults. BERA is a non-invasive and the most cost-effective method for diagnosing retrocochlear lesion.

Approximately 1 of every 1000 children is born deaf. Early diagnosis of hearing impairment is important as the rehabilitative procedure can be started early which help speech and language development. It is impossible to perform pure tone audiometric tests on children but BERA provides rapid and efficient way to screen for deafness.

BERA is an objective study for assessing hearing loss on patients with inconsistent responses on pure tone audiogram. BERA helps to assist with detection of lesions like vestibular schwanommas, multiple sclerosis, stroke, trauma etc. BERA is a non invasive technique, easily recordable, not affected by sedation, anesthesia or age; hence the present study.

Objectives

1. Screening tool for evaluating cases of sensorineural hearing loss due to suspected retrocochlear pathology
2. Screening of deafness in pediatric age group
3. Objective test in cases of inconsistent response for pure tone audiometry
4. Role in evaluating brainstem lesions

Materials and Methods

This study entitled "Brainstem evoked response audiometry (BERA) and its applications in ENT" was conducted in department of ENT, Vijayanagara institute of medical sciences, Bellary during June 2019 to December 2020.

Source Of Data

The patients attending the department of ENT and also patients referred from other departments of combined hospitals of MCH VIMS, Bellary form the subjects for our study in whom PTA or BERA can be done and are willing, during June 2019 to December 2020.

Sampling Size: 50

Inclusion Criteria:

1. Suspected cases of retrocochlear hearing loss.
2. Pediatric patients with sensorineural hearing loss.
3. Patients with inconsistent response on pure tone audiometry.
4. Trauma and comatose patients.

Exclusion Criteria

1. All patients with conductive or mixed type of deafness were excluded.

The evaluation is done in following stages:

A written informed consent is taken from all patients included in the study. A detailed history-taking, thorough clinical examination done for these patients. The data collected is being entered into a specially designed case record form.

Pure tone audiometry (PTA)

The average hearing threshold is calculated by taking average of hearing threshold at 500, 1000, 2000 Hz.

I: BERA apparatus

Machine used for recording BERA was RMS EMG EP MARK-II machine manufactured by RMS RECORDERS and MEDICARE SYSTEM, Chandigarh.It is a computerized machine with facilities like- artifact rejection and common mode rejection

II. The room

The test was carried out in pre-cooled (temperature 21 degree centigrade) sound treated room. The electrical interference was kept minimal by spacing away the test room transformers, lifts etc. the room was spacious 10 feet by 10 feet with couch to lie down for patient.

III. Pre Test preparation

Each test carried out with prior appointment. Patient was subjected to ENT and pediatric examination prior to test. Patient was instructed to clean scalp with shampoo and not apply oil. Children given sedation syrup tricloryl as per dose recommended by pediatrician.

IV. Preparation of patient

Patient was made to lie down on couch with head supported by pillow. Skin was prepared with surgical spirit. Electrode gel (Ten 20 conductive gel) was applied. Gel is non staining, non irritant to skin, sodium chloride free, water soluble.

V. Electrode placement

Silver electrodes were used and applied in following fashion:

Cz	Vertex	Δ
Active	Testing ear mastoid	+ve
Non active	Non testing ear mastoid	Ground

Electric impedance is always kept less than 3K Ohms and difference between electrodes was not more than 1K Ohms.

VI. The machine setting

Acoustically shielded TDH 32 earphones were used to cut down acoustic interference. Stimulus was given in the form of clicks at a rate of 11.3 per second. Each click duration was kept between 150 to 3000 Hz. Analysis time was 10 ms, 2000 responses were averaged.

VII. In pediatric age group

The test was started after baby is asleep. The first stimulus was given at 125 dBnHL level (maximum intensity available) and decreased by 10 dBnHL for next run if wave V present. Both ears were tested separately. At each intensity run efforts were made to identify wave V. it was confirmed by re-run. Presence of peak V was taken as ability to hear. Each patient was categorized into normal, mild, moderate and severe hearing loss.

VIII. In adults

The test was started after the patient was lying still on couch and comfortable. First PTA thresholds for clicks were determined and better ear was tested. Then stimulus presented was

1. At 60 dB sensational level, whenever it was possible to give 60dB SL in both ears.
2. Otherwise when there was disparity in thresholds, the threshold for clicks for worse ear was found out using masking. Then considering the maximum limit of intensity available the sensational level was calculated and the test was carried out on both ears at this particular sensational level. Each ear was tested separately and masking was used in worse ear whenever required.

From BERA waveform thus obtained following calculations were made

1. Inter aural latency difference in I-V inter peak interval
2. I-V Inter peak interval
3. Inter aural difference in wave V latency
4. Absolute latency of wave V
5. Selective loss of late waves
6. Grossly degraded wave form morphology

Guidelines used to identify wave V are

1. Appears after latency of 5 milliseconds (mean 5.7±0.25 ms)
2. With decrease stimulus intensity its latency increases.

3. Can be reproduced following re-run.
4. Absence of peak in neutral run.

We used normative values determined by Gupta and vishwakarma[31] in Indian setup.
The report of test was given in the format shown in proforma. Statistical test and Mc. Namara's test was applied whenever applicable.

Results and Observations
The observations recorded in the study are described under following headings:

Pediatric Age Group
In our study pediatric age group ranged from 8 months to 168 months (14 years), mean age 66.61 months with standard deviation of 48.16 months. Most of the children were in the age group of 6 to 10 years.
In our study, in pediatric age group the number of male patients were 22 (61.1%) & female patients 14 (38.9%) with a male: female ratio of 3:2
The most common presenting complaint in our study in the pediatric age group was bilateral hard of hearing since birth.

Presenting Complaints	Frequency	Percent
b/l hard of hearing since birth	13	36.1
b/l hard of hearing since few months	6	16.8
normal screening	17	47.6
Total	36	100.0%

Perinatal History: In our study maximum pediatric patients (36.1%) had normal perinatal history, apart from which post-meningitis (27.8%) was the most common perinatal history.

Perinatal History	Frequency	Percent
autistic child	1	2.8%
low birth weight	6	16.7%
mentally retarded	2	5.6%
neonatal jaundice	2	5.6%
normal	13	36.1%
post meningitis	10	27.8%
preterm baby	2	5.6%
Total	36	100.0%

Absolute Latency of V (ms)
The absolute latency of wave V was normal in 26 patients (72.2%) and abnormal in 10 patients (27.8%) in our study among the pediatric age group. The mean absolute latency of wave V is 5.76±0.39 ms in left and 5.75±0.41 ms in right ear.

Interaural Difference in Wave V Latency (ms)
In our study the interaural difference in wave V latency was normal in most patients (83.3%) & abnormal in 16.7% in the pediatric age group.The mean interaural difference in wave V latency is 0.02±0.03 ms.

Interpeak Latency I-V (ms) Right Ear
The interpeak latency I-V for the right ear was abnormal in 19 patients (52.8%) & normal in 17 patients (47.2%) in the pediatric age group in our study. The mean interpeak latency I-V for the right ear is 4±0.01 ms.

Interpeak Latency I-V (ms) Left Ear
The interpeak latency I-V for the left ear was abnormal in 19 patients (52.8%) & normal in 17 patients (47.2%) in the pediatric age group in our study. The mean The mean interpeak latency I-V for the left ear is 4±0.01 ms.

Interaural Latency Difference In I-V Interpeak Interval
In our study in the pediatric age group the interaural latency difference in I-V interpeak interval was abnormal in 19 patients (52.8%) & normal in 17 patients (47.2%). The mean interaural latency difference in I-V interpeak interval was 0.0094±0.0075.

Grossly Degraded Wave
In our study in the pediatric age group normal wave was seen in 16 patients (44.4%), only wave V was present in 13 patients (36.1%), wave V & III in 1 patient (2.8%) & no wave could be identified in 6 patients (16.7%).

Interpretation

Interpretation	Frequency	Percent
No Wave Identified	6	16.7%
Normal Wave With Normal Latencies	15	41.7%
Only Wave Iii And V Identified	1	2.8%
Only Wave V Identifiedat 120 Db	14	38.9%
Total	36	100.0%

In our study in pediatric age group, 15 cases(41.7%) was interpreted normal wave with normal latencies after analysing all the values. Only wave V identified in 14 cases (38.9%) in children with profound hearing

Conclusion
In our study in pediatric age group, 15 cases(41.7%) had normal hearing on screening, 13 cases(36.1%) had profound hearing loss without any risk factors, 6 cases(16.7%) had hearing loss due to meningitis complications, 2 cases(5.6%) had hearing loss due to neonatal jaundice.

Conclusion	Frequency	Percent
Bilateral Profound Hearing Loss	13	36.1%
Profound Hearing Loss Post Neonatal Jaundice	2	5.6%
Severe To Profound Hearing Loss Post Meningitis	6	16.7%
Normal Hearing	15	41.7%
Total	36	100.0%

Inference
Children with risk factors are 1.65 at more risk of developing hearing loss when compared to normal children; but statistically not significant.

Adults
In our study the mean adult age was 57.50 years with a standard deviation of 14.36, most patients belonged to age group >60years.In our study, in the adult age group the numbers of male patients were 8 (57.1%) & female patients were 6 (42.9%) with male predominance.
In our study in the adult patients the most common presenting complaint was hard of hearing present in all patients (100%), 2 cases (14.3%) had associated tinnitus and one case (7.1%) had associated tinnitus and giddiness.

PTA Right Ear: In our study in the adult patients PTA right ear showed moderately severe hearing loss in most (42.9%) patients followed by severe hearing loss (35.7%).The mean pure tone audiometry value on right side is 63.91±14.62 dB.

PTA Left Ear: In our study in the adult patients PTA left ear showed moderately severe hearing loss in most (42.9%) patients followed by moderate hearing loss (28.6%).The mean pure tone audiometry value on left side is 54.40±13.72 dB.

Absolute Latency of V Right Ear (ms): The absolute latency of wave V in the right ear was normal in 12 patients (85.7%) and abnormal in 2 patients (14.3%) in our study among the adult age group. The mean absolute latency of wave V in the right ear was 5.57±0.13 ms.

Absolute Latency of V (ms) LEFT EAR: The absolute latency of wave V in the left ear was normal in 13 patients (92.9%) and abnormal in 1 patient (7.1%) in our study among the adult age group.The mean absolute latency of wave V in the left ear was 5.69±0.12 ms.

Interaural Difference in Wave V Latency (Ms): In our study the interaural difference in wave V latency was normal in most patients (78.6%) & abnormal in 21.4% in the adult age group. The mean interaural difference in wave V latency was 0.0182±0.0060 ms.

Interpeak Latency I-V (ms) Right Ear: The interpeak latency I-V for the right ear was normal in 12 patients (85.7%) & abnormal in 2 patients (14.3%) in the adult age group in our study. The mean interpeak latency I-V for the right ear was 4.0017±0.0103 ms.

Interpeak Latency I-V (ms) Left Ear: The interpeak latency I-V for the left ear was normal in 13 patients (92.9%) & abnormal in 1 patient (7.1%) in the adult age group in our study. The mean interpeak latency I-V for the left ear was 4.02±0.0598 ms.

Interaural Latency Difference In I-V Interpeak Interval: In our study in the adult age group interaural latency difference in I-V interpeak interval was normal in 11 patients (78.6%) & abnormal in 3 patients (21.4%).The mean interaural latency difference in I-V interpeak interval was 0.0091±0.0054 ms.

Grossly Degraded Wave

In our study in the adult patients normal wave was seen in 11 patients (78.6%) & grossly deformed wave was seen in 3 patients (21.4%).

Interpretation: In our study in adults all waves were identified in 11 cases (78.6%) helping in threshold estimation and only wave I identified in 3 cases(21.4%) with suspicion of retrocochlear pathology.

Conclusion

Conclusion	Frequency	Percent
? Braisntem Lesion/Retrocochlear Pathology	1	7.1%
? Retrocochlear Pathology	2	14.3%
Mild To Moderate Snhl In Right Ear And Severe Snhl In Left Ear	1	7.1%
Normal Hearing ?Malingering	1	7.1%
B/L Profound Hearing Loss	2	14.3%
Profound Snhl In Right Ear And Severe Snhl In Left Ear	2	14.3%
Severe Snhl In Right Ear And Mild Snhl In Left Ear	1	7.1%
Severe Snhl In Right Ear And Moderate Snhl In Left Ear	3	21.4%
Severe Snhl In Right Ear Normal Hearing In Left Ear	1	7.1%
Total	14	100.0%

Discussion

In our study in adults maximum patients had different severity of hearing loss 10 cases(70.1%), 2 cases had suspected retrocochlear pathology with history of hearing loss and tinnitus and absent waves apart from wave I suggesting lesion in auditory pathway. One case had above features plus giddiness suspicious of brainstem lesion/retrocochlear pathology. One case had normal hearing who had hearing loss on PTA with inconsistent responses suggesting of normal hearing/malingering.

In our study in pediatric age group 15 cases (41.7%) were found to have normal hearing, 13 cases (36.1%) had profound hearing loss since birth, 6 case (16.7%) had hearing loss post meningitis, 2 cases (5.6%) had hearing loss secondary to neonatal jaundice episode.

When compared to children who had risk factors with normal perinatal history children, Children with risk factors are 1.65 at more risk of developing hearing loss when compared to normal children; but statistically not significant as number of children were less.

In a study done by Northern JL, Hayes D: Universal screening for infant hearing impairment, approximately 10% of all newborns are at risk for some type of developmental disability including hearing loss[42]. Of these newborns at risk, 30% to 50% of every 1,000 have hearing impairments.

In adults 10 cases(70.1%) had hearing loss due to normal aging process, 2 cases(14.1%) had suspected retrocochlear pathology, one had suspected brainstem/retrocochlear lesion(7.1%) and one case(7.1%) was suspected malingering.

In our study in adults 2 cases had suspected retrocochlear pathology with history of hearing loss and tinnitus and absent waves apart from wave I suggesting lesion in auditory pathway. One case had above features plus giddiness suspicious of brainstem lesion/retrocochlear pathology. One case had normal hearing who had hearing loss on PTA with inconsistent responses suggesting of normal hearing/malingering.

Conclusion

In our study BERA was effective in identifying hearing loss thresholds by identifying wave V and its threshold and assessing auditory pathway in infants and children's depending on the wave latencies. BERA along with Otoacoustic emissions can be used for newborn hearing screening.

BERA helps in predicting hearing loss where PTA shows inconsistent responses and also helps in identifying malingerers as BERA is an objective test.

BERA can be used to screen retrocochlear pathologies as seen in our study. Patients with hearing loss with tinnitus and giddiness screened and BERA performed had grossly degraded wave with identification of only wave I and absence of other waves and increased latencies and interaural difference in wave latencies suggests lesion in the auditory pathway. Depending on the absence of specific wave site of the lesion can also be made out. In our study 3 cases of retrocochlear pathology previously confirmed by MRI was taken and BERA was performed showing presence of only wave I and absence of remaining waves. BERA is screening test and should be confirmed by MRI.

Summary

This study was undertaken with the objective of evaluating the role of brainstem evoked response audiometry(BERA) and its applications in ENT in a setup like our hospital where screening of hearing in children, initial test to screen retocochlear pathologies, predict hearing thresholds can be done.

Fifty cases i.e. 100 ears were evaluated and BERA was performed on them after taking consent and after ENT examination. Values obtained were interpreted and results were given, statistics evaluation done and compared to other similar studies.

BERA is the accurate and reliable estimation of hearing levels in infants and young children and helps in early identification of hearing impairment and rehabilitative measures can be taken. In our study BERA was effective in identifying hearing loss thresholds and assessing auditory pathway in infants and children's in whom behavioral methods and PTA evaluation is not possible and in children with significant perinatal history with risk of developing hearing loss. BERA is non-invasive, easy to perform and interpret and cost effective screening test to assess hearing loss in infants and children which can be done in any OPD settings.

BERA is the accurate and reliable method for prediction of hearing loss in adults. It helps in predicting hearing loss where PTA shows inconsistent responses and also helps in identifying malingerers as BERA is an objective test.

BERA helps in evaluating cases of retrocochlear pathology/brainstem lesions. With history of hard of hearing with tinnitus/giddiness and SNHL on PTA, further evaluating with BERA, loss of waves or waves with increased latencies and interaural latency differences suggest retrocochlear pathologies. It is an effective screening test to diagnose retrocochlear pathologies which further has to be confirmed by MRI.

Though time consuming BERA is a non invasive, objective test in identifying hearing loss in infants and children, estimating hearing thresholds in uncooperative patients and as a screening test to diagnose retrocochlear pathologies and should be used as a part of routine audiometric test battery along with other tests to confirm and diagnose accurately.

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