A Quiz on ABR

Register No. M 9511

An Independent Project submitted as part fulfilment for the
First Year M.Sc. (Speech & Hearing)
to University of Mysore.

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MYSORE - 570 006
1996

Dedicated

to

Pop's Akka , Pri, Gau, Di, & Pap's

CERTIFICATE

This is to certify that the independent project entitled
"A Quiz on ABR *"is a bonafide workdone in part fulfilment of the first year degree of Master of Science (Speech & Hearing), of the student with Regester No .M9511.*

Myso re
1996

Director
All India Institute of Speech and Hearing
Mysore - 570 006

C E R T I F I C A T E

*This is to certify that the independent project entitled "**A Quiz on ABR**" has been prepared under my supervision and guidance.*

Mysore
1996

Dr. (Miss) S. Nikam
Guide

DECLARATION

I here by declare that this independent project entitled **"A Quiz on ABR"** *is the result of my own study under the guidance of Dr. (Miss) S. Nikam,Professor and Head, Department of Audiology, All India Institute of Speech and Hearing Mysore, and has been submitted earlier at any other University for any other Diploma or Degree.*

Mysore
1996

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Cheers to ***Swapna & Rajo.***

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Reg. No. M 9511

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QUIZ ON ABR A VIDEO FILM

INTRODUCTION:

An important element in the study of the human auditory system and its disorders involve the testing of the auditory system.

There are different subjective and objective way of testing human auditory system. Out of which ABR is an effective measure for objectively detecting damage to the auditory system. It has became a very important tool in the field of clinical audiology, Otology, neurology, neurotology and its one of the widely used electric response Audiometry. ABR is most often evoked by DC electrical pulse which when transduced by standard earphones, produces acoustic click.'

It has been used in clinical audiology to estimate hearing function in infants and young children and to monitor auditory function.}

The ABR is recorded by attaching electrodes to the surface of the scalp and amplifying the electrical activity obtained immediately following an auditory stimulus. The response is low in amplitude and is buried in other ongoing activity in the nervous system. Therefore special common mode rejection amplification response filtering and computer averaging are needed to differentiate the response to the stimulus from the other activity.

Early reports on the ABR were produced by Jewett Romano and Williston (1970). Jewett and Williston (1971) and Sohmer and Feinmesser (1967)

A normal ABR wave form is characterized by 5 to 7 peaks that occur with in 1.4 to 8.0 milliseconds Jewett and Williston (1971) gave Roman numericals to be used for these peaks.

The prominent waves are I, III and V. These waves originate from different places of central auditory nervous system.

The quality and reproducibility of the ABR is quite Independent of the state of the subject and can be obtained in subjects who are under general anesthesia or comatose. Because of this replicability, consistency among subjects and sensitivity to disorders in these Auditory Pathways, ABR has become an important tool in both clinical evaluation and intra operative monitoring.

ABR obtained in premature and full term infants vary from these obtained in Adults various age related changes in ABR wave form like Morphology latency and amplitude should be known to an audiologist to arrive at an appropriate diagnosis.

(The electrophysiological or evoked responses to acoustic stimuli comprises of a series of neuro electric responses generated at all levels of the Auditory Mechanism. These potentials can be recorded by using electrodes at the site of electrical activity.

Its hoped that this video film on ABR quiz will be useful for providing basic- information regarding the history of auditory brainstem response the instrument used, the procedure involved in obtaining the responses and various audiological and pathological applications of the ABR.

METHODOLOGY

This project aims at conducting a quiz on ABR the methodology of the present study is described under the following sections.

I.Subjects

II. Selection of questions and rounds

III. Scoring

IV. Questions.

Subjects:

Four post graduates and four graduates from Speech and Hearing were selected and were grouped randomly into four teams of two each.

Selection of questions and rounds:

The questions were selected from literature. The question were grouped under the following headings.

I -Historical background

II - Instrumentation

- Anagram

- Electrodes

III - Abbreviations (or) Acronyms

IV - Rapid five questions

V - Visual Round

Historical Background:

Questions related to the History of Auditory Brain stem response were selected in this section.

Instrumentation:

Questions regarding the instrument used in the measurement of Auditory brain stemresponse were choosen and were further subdivided as Anagrams and questions based on electrodes.

Acronyms:

Acronyms regarding the different evoked potentials were included under this section.

Rapid Five Round:

Various questions regarding auditory brain stem response were choosen under this section.

Visual round:

And the last round round is the visual round. In this round each team is shown a visual's regarding the ABR.

Scoring:

For section one and two, five points were awarded for correct answers, for incorrect answers no points were granted and the questions were not passed.

For the 3 rd section 10 points were awarded for correct identification and five negative points for incorrect identification. Each team was given 20 seconds to answer a question.

The rapid fire question, each team were expected to answer a set of four question within 40 seconds and five points were awarded for the correct answer. The final section (ie) visual round each team is shown a visuals for 10 seconds and for correct answers 20 points were awarded.

I. What does the history of the ABR convey ? Few important names and dates.

(1) The early begining of evoke response audiometry was made way back in the year.

(i) 1875 (ii) 1850 (iii) 1905

Ans. 1875

(2) Response classification based on latency epoch was done *in* the yearl976 by

(i) Caton (ii) Sohmer (iii) Davis

Ans. Davis

(3) Jewett & Williston recorded the brain stem response in the year

(i) 1971 (ii) 1973 (iii) 1985

Ans. 1971

(4) Neural loci in Human was given in the year 1985 by

(I) Bushwald (ii) Haung (iii) Jacobson

Ans. Jacobson

II. INSTRUMENTATION:

(A) Anagrams:

(1) Dolu Preaks - Loud speaker

(2) Eaprohen - Ear phone

(3) Apmelfiir - Amplifier

(4) Ranectsdru - Transducer

(B) Instrumentation:

(1) The equipment to measure ABR comprises of how many parts?

Ans. 2 parts

(2) The stimulating apparatus of ABR has 2 parts what are they or name one of them :

Ans. Audiometer, transducer

(3) Name any two stimuli used in ABR

Ans. Clicks, Tonal stimuli, Filtered clicks Tone Pips, and Tone burst.

(4) The electrical wave form is converted into acoustic energy in ABR by what

Ans. Transducer (ex) earphone, bone vibrator

C) Electrodes:

(1) How many electrodes are usually placed.

Ans. 3

(2) What is the active electrode otherwise called ?

Ans. Inverting electrode

(3) What is the reference electrode otherwise called?

Ans.Inverting elctrode.

(4) Electrode: Impedence should not exceed How many OHMs

Ans.-5000 OHMs

(5) Where is the reference electrode placed for ABR?

Ans. Ear lobe or Mastoid of the non test ear.

(6) Where is the active electrode plfaced for ABR?

Ans. Ear lobe or mastoid of the TEST ear.

(7) Where is the ground electrode placed for ABR?

Ans. High on Fore head

(8) What type of electrode is used in ABR?

Ans. Surface electrode.

(9) Electrode Impedence should not exceed How many OHMs?

Ans. 5000

III. These are commonly used abbreviations (or) acronyms which have an extra letter added to them eliminate the unwanted letter and expand it.

(1) ERBA - Auditory Brainstem response

(2) GEER- EEG - Electroencephalogram

(3) MCA - CM - Cochlear Micro Phonics

(4) DSP - SP - Summating potentials

(5) PAT - AP - Action potential

(6) N1oSN - SN1o - Slow Negative 10

(7) F_R F_R FFR - Frequency following response

(8) ARLM - MLR - Midlatency response

IV **True or** False:

(1) The receptor potential generated from the hair cells consists of the action potential.

False - CM & SP

(2) Neurogenic potentials originate from the acoustic nerve

True

(3) Click stimuli stimulate The entire length of the cochlea

True

(4) Filtered clicks are got by passing through low pass filters.

False - High pass and low pass filters.

(5) The recording apparatus consists of the following, Electrodes, Amplifier, Filters, Averager and Display printout.

Ans. True

(6) Wide band filters are used to eliminate background noise from the amplified signal.

Ans. False - Narrow band filters.

(7) The average used in ABR averages only 500 stimuli

Ans. **False - 2048**

(8) The averaged stimuli are displayed in the oscilloscope.

Ans. True

(9) Test room should be free from electrical and electromagnetic interferences.

Ans. True

(10) The ABR wave form consists of 12 to 15 peaks

Ans. False - 5 to 7 peaks

(11) ABR issued to find the Maturation of the Auditory Pathway in Infants and Neonates.

Ans. True

(12) ABR cannot check neurological Integrity in some paediatric population.

Ans. False.

(13) ABR can detect 8th nerve and low brain stemlesion.

Ans. True.

(14) In case of multiple sclerosis there is abnormality of symmetry, delay in Latency, Fragmented response and decreased amplitude.

Ans. True.

(15) ABR cannot be used in Intra operative monitoring.

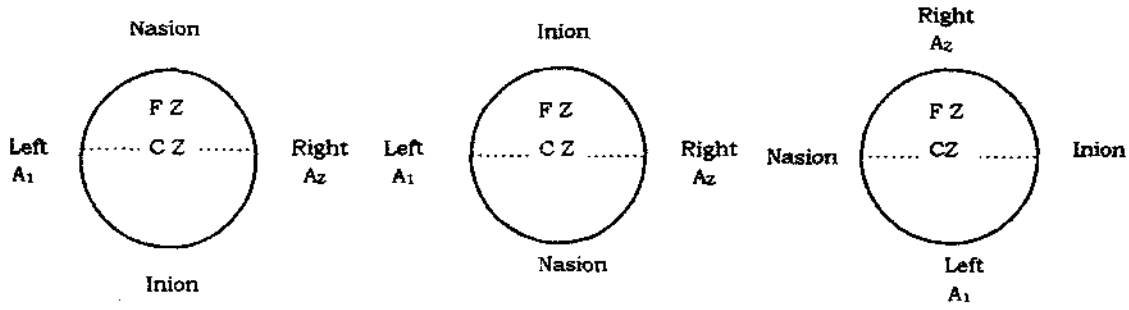
Ans. False

(16) Normal ABR Indicate good neurological outcome in comatose patients.

Ans. True.

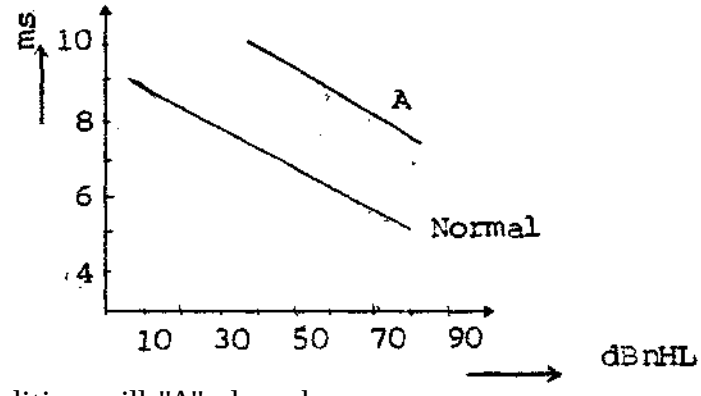
Visual Round:

(1) Which of these placement is correct for ABR



Ans. 1

(2)

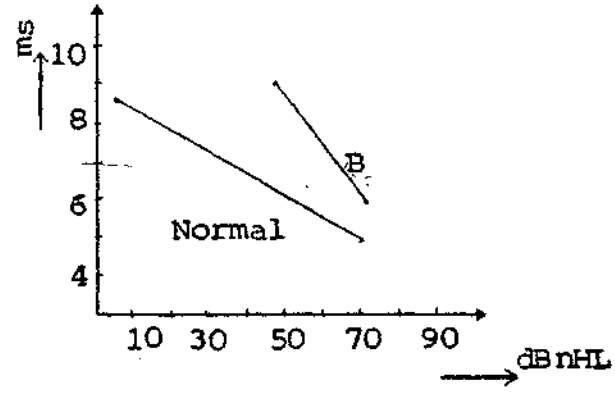


In what condition will "A" slope be seen

(I) Extra axial Lesion, (ii) Conductive Pathology, (iii) Newborn

Ans. Conductive pathology

3)



In what condition will the "B" slope be seen

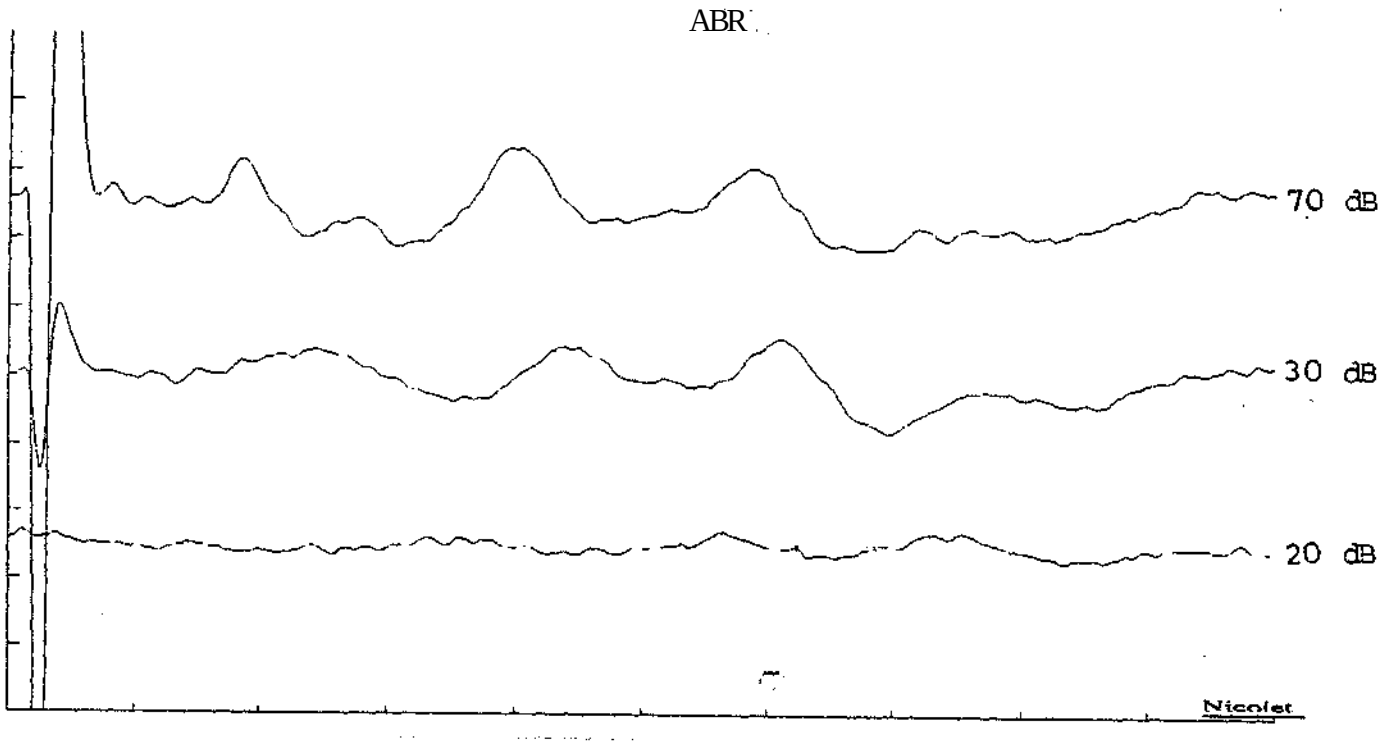
(I) Retrocochlear Pathology (ii) Cochlear Pathology (iii) Conductive pathology

Ans Retrocochlear Pathology

(4) What will be the threshold of this client?

(I) 70 dBHL *(ii)* 5 dBHL (iii) 15 dBHL

Ans: 15 dBHL



Auditory Brainstem response (ABR)

The ABR is a representation of the synchronous discharge of onset sensitive single units of first through sixth order neurons of the peripheral and central auditory nervous system, to a click brief tone burst. It is not a test of conscious hearing, but inconjunction with other procedures, can be used to infer auditory sensitivity Hood and Berlin, 1986).

Historical Perspective

The early beginning of evoke response audiometry was made way back in 1875 when caton noted the presence of electrical potentials in the brain.

Berger (1929) went on to record the 1st human electro encephalograph (EEG) from electrodes placed on the scalp.

Somer and Feinmesses (1967) were the first researchers to work on non invasive electrode placement and they offered the first account of Electrical Potential generated from Brainstem. They reported a series of four wave components, the 1st two waves comprising the N1 - N2 complex of the auditory nerve AP. The latter two waves were of questionable origin and it was explained that these responses were either the result of repetitive firing of the acoustic nerve or neural discharge pattern from the brainstem pathway.

Jewett & Williston (1971): reported recordings in humans reported a series of five to seven peaks within 7 milliseconds of stimulation and also used Roman numericals I - VII and this nomenclature continues to be commonly used.

Hecox and Gralambos 1914 used the term Brainstem auditory evoked response as the components of the wave series, were derived from the Brainstem.

Davis (1976) described the responses in order of their latency epoch as

First - 0 - 2 ms

Fast - 2 - 10 ms

Middle- 8 - 50 ms

Slow - 50 - 300 ms

Late - 300 ms

Gibsen 1978: used the term acoustic brainstem electrical response because the response could be obtained even from Decerebrate animals.

Jacobson 1985 reported that in case of humans the neural loci of the various waves are:

Wave I	neural activity in the cochlea
Wave II	Between the cochlea and the cochlear nuclei.
Wave III	The cochlear nuclei
Wave IV	Superior olivary complex
Wave V	Lateral laminscus
Wave VI	Inferior colliculus
Wave VII	Medial geniculate body.

Nomenclature and classification

There have been several approaches to classify AEPs descriptions usually include at least one of the following aspects.

1, Response latency 2, anertomic orgin 3, stimulus response relationship, 4) electrode placement. One classification is based on the latency "epoch" of the response. In this context an 'epoch' is defined as a range of latency in which several AEP components may appear. The various components are designated as First (0 - 2 ms), Fast (2-10 ms), Middle (10 - 50) slow (50 - 300 Msec) and late (300+ msec)

Stimulus response

Epoch	Transient	Sustained	Perceptual cognitive
First	AP	CM.SP	-
Fast	ABR, SN1o	FFR	-
Middle	MLR 40Hz	-	-
Slow	SVR	-	-
Late	-	SCP	P300

Another classification involve the stimulus response relationship. Responses have been classified as transient , sustained or perceptual, reflecting the feature of the stimulus which is critical for response generation. A transient response is critical for response generation. A transient response is evoked by a rapid change in the stimulus such as its onset or offset. In contrast a prolonged stimulus may evoke a sustained response which lasts for the duration of the stimulus. Perceptual response generation usually requires the use of a stimulus paradigm which imposes some cognitive significance on the stimulus such as discrimination tasks.

Neuroelectric Activity:

The usefulness of ABRs in making oto neurological diagnoses depends upon knowing the anatomical origin of the various components of the ABR that can be identified upon knowing how various pathologies change these potentials. It is generally accepeted that the ABR recorded

from electrodes placed on scalp represent the far field of the potentials generated by the fiber tracts and nuclei of the ascending pathway.

Neural Generators:

Electrical potentials of the ear and the auditory nerve:

Several different sound evoked potentials can be recorded from the cochlea: the cochlear microphonics, the summating potentials (SP) and the compound action potential (CAP). Different types of sound stimuli may evoke all three potentials but each potential is most clearly elicited in response to a particular type of sound.

Several studies using microelectrodes comparing the ABR recorded at far field and the ABR recorded directly along the auditory pathway. From these studies the following conclusions were made :

1. Peak I and II are generated by the auditory nerve. Peak I is generated at the distal part of the auditory nerve and Peak II is generated primarily from the proximal part of it.
2. Peak HI is generated mainly by the ipsilateral cochlear nuclei and may receive a small contribution from the eigth nerve fibres entering the cochlear nuclei.
3. Peak IV is generated by the third order neuron (i.e) the superior olivary complex. Also contributing to the wave IV are the cochlear nuclei and probably the lateral lemniscus nuclei.
4. The origin of the positive component of wave V is the lateral laminiscus. Other nuclei in the vincinity have a minor contribution to the generation of Peak V is the Inferior colliculus.

Furthermore wave VI and VII are attributed to be originating from inferior colliculus.

Instrumentation in ABR

The magnitude of ABR is very small approximately 0.01- 1/microvolt this small potential is masked by the larger background electrical activity (EEG) within the brain myogenic activities in the skull region electrical radiation from electronic devices in the environment such as 60 Hz hum, and other faults produced while generating the stimuli or recording the potential. Therefore, in order to identify AEPs special equipment is required. **The instrumentation set up for recording ABR can be divided into 3 core division.**

1) Differential preamplifier 4 filter
2) Common mode rejection ratio
3) Signal averages.

The Amplifier and Filter:

The physiological amplifier must be able to eliminate the 60 Hz hum. This could be done using a differential physiological amplifier. The differntial amplifier has two stages. The first stage called the preamplifier stage, receives three inputs (1) the 1st input to the preamplifier is from the vertex of the scalp and called non inverting or positive waveform its called the non inverted wave form.

(2) The second input from the reference site of the scalp to these amplifier is the negative or inverted wave form.

(3) the 3rd input to the preamp is called the common or neutral input.

The second stage of the amplifier amplifies the input approximately 100,000 times (10^5) The output of the second stage passes through the filter. The filter is designed to increase the signal to noise ratio prior to signal averaging. The band pass of the filter is adjusted to reject background activity unrelated to the potential.

(eg) only frequencies between 100 and 3000 Hz will be passed.

2. Common Mode Rejection Ration:

Its used to describe the extent to which the common inputs, such as the 60 Hz, Thus at the inverting and non inverting electrodes are cancelled out.

3. Signal averages:

Its function is to store electrical response which that are time locked to the stimulus and to cancel out the ongoing EEG activity. The averages serves to obtain a clear response. Usually 2048 stimuli are averaged.

Physical characteristics of the ABR:

The criteria for ABR Interpretation are based, in general on the

(a) Latency : 1. Latency of the individual wave form (absolute latency)
2. Interpeak latency.,

(b) Amplitude: 1. Peak amplitude (absolute amplitude)
2. Ratio of amplitude or V/I.

(c) Morphology of the wave form (or) wave form morphology.

(I) Absolute latency:

The absolute latency of wave form V, the rostral component of the ABR has received the most widespread clinical attention in differential diagnosis of otoneurologic disorders as well as threshold estimation.

The importance of wave V relates to its robust character and reliability undervarying measurement conditions;; with decreased stimulus intensity the wave V latency increases proportionally and by a predictable amount.

The earlier primary waves I and III becomes unstable as intensity is reduced much below 50 dBnHL.

(ii) **Interpeak Latency:**

Critical to the differential diagnosis of space occupying lesions, either intrinsic or extrinsic to the brains tern, and the disruption of the neuroelectric activity secondary to demylinating disease, is the time difference between two primary peaks (I, III, V) obtain described as the interpeak latency (IPL) or interwave interval (IWI). This time interval reflects in part, neural conduction time and has been called a central transmission time (LTT) or brainstem transmission time (BTT)

(iii) Waveform amplitude:

Measures of response amplitude in micro volts have not met with a great deal of clinical success, owing partly to the variability of the measure. Amplitude values don't appear to be normally distributed are highly susceptible to myogenic activity or noise level and are easily influenced by minor alterations in recording techniques.

(iv) Ratio of amplitude of Peak V and I

V/I amplitude ratio has gained significant clinical valve in recent years. In normal patients, wave V is usually greater inamplitude than wave I, resulting in an amplitude ratio of > 1.00. Hence an amplitude ratio of <1.00 is considered abnormal and is indicative of retrocochlear pathology.

(v) Waveform morphology

Morphology refers to the visual appearence or actual shape of the averaged wave. This factor is very subjective and at best, a qualitative discriptor clinical experience show sufficient variability in response morphology among normal subjects.

The well known IV/V complex is not always apparent at times, wave V seems to ride just below the crest of peak IV or there may be a total fusion of both into one broad peak.

Similarly its not uncommon to show bifurcation of wave I and/or III thus making it difficult to measure latency if one uses a peak reference point of particular importance is that response morphology can be affected by age, pathology and measurement related variables. In essence, therefore alterations in wave morphology represent 'soft' clinical signs of neuro auditory pathology.

Factors influencing the normal ABR

(I) Filter characteristics

As with most bioelectric potentials, the ABR is embedded within a background of competing electrical activity (EMG). The morphology of the averaged evoked potential will loose considerable resolution unless the frequency response of the recording system is set to reject the maximal amount of electrical interference. One method of optimizing response clarity by reducing the S/N ratio is that of Band Pass filtering investigators have applied various band pass filter settings to record the ABR.

The choice of filter settings should be predicted on the frequency composition of the desired bio electrical potential as well as on the

interfering myogenic noise. As can frequency cut off of the band pass filter is increased to 300 Hz the category of all the waves decrease and the amplitude of V decreases relative to that of wave IV. The effect on the amplitude of wave V is most marked as the low frequency cut off is increased from 100 Hz to 300 Hz. Thus a low frequency cut off of 100 to 150 Hz is prefferred. As the high frequency cut off of the band pass filter is increased from 300 Hz to 3000 *Hz* the latencies of all the waves decrease and there is improvement in the resolution beyoind 3000 Hz the resolution of waves IV and V is not improved further and high frequency noise is added to the wave form.

(ii) Sample size

The electrical activity recorded following auditory stimulation consists of both the time-locked response to the signal and the ongoing EEG activity (the noise) in the averaging process, auditory stimuli are repeatedly presented to an ear and the wave forms elicited by each stimulus are averaged. If one stimulus to be constant, then the averaging process should reduce the noise amplitude and thereby improve the S/N ratio the greatest enhancement in the S/N ratio occurs in the first 300 - 1000 samples. Stockard et.al., (1978) recommended the use of at least 2,000 samples per average.

(iii) Stimulus Rate

As the click rate (repatitionarate) increases the absolute latencies of all the ABR waves and Interwave interval increases.

At high repetion rates the wave V and IV often merge Its as the Repetition Rate increases the amplitude of the ABR component decreases particularly for the earlier components.

At high Repetition Rate, the V/I amplitude ratio increases since the amplitude of wave I is more adversely affected than that of V by rate increase.

Repetition rates below 33/sec are recommended for routine clinical use, particularly for the identification of wave I is more adversely affected than that of V by rate increase.

Repetition rates below 33/sec are recommended for routine clinical use, particularly for the identification of wave I in neurologic diagnosis.

To prevent the 60 Hz hum in the ABR wave form the stimulus rate should not be a multiple of 60 Hz thus Repetition Rate of 11.4 or 33.1 are acceptable.

IV. Stimulus Polarity:

Rarefaction, condensation or alternating polarity signals are employed in ABR assessment. Rarefaction clicks tend to be associated with shorter absolute peak latencies as compared to condensation clicks at lOdBSL. Several studies have suggested significant effects on the physical characteristics of wave I in the direction of decreased latency, increased amplitude and improved resolution with application of rarefaction click stimuli. This shortening of wave I latency will influence the subsequent measures of IPLS - Given the importance of wave I in otoneurologic investigation, it would appear more prudent to employ a rare faction click phase.

(v) Analysis Time

Analysis time or sweep time is the number of milli seconds after the stimulus onset that the signal averages continues to sample the responses. In adults the recommended analysis of time in 10 ms. In neonates because of the prolonged peak latencies compared with those of adults, the prefered analysis time of 20 ms in neonates. Because of the immaturity of the auditory nervous system in neonates the latency is prolonged.

(vi) Electrode Impedence

Electrode impedence value should not exceed 5,000 ohms in adults; below 3,000 ohms is preferable. Difference between electrodes impedence ideally should not exceed 1,000 ohms. In infants the electrode impedence value may reach 1,000 - 1,500 ohms.'

(vii) Plotting convention

When the positive input to the signal averager has a greater magnitude then the negative in put, the deflection is directed upward on the oscilloscope. In ABR assessment, the vertex and the Ipsilateral ear lobe (or mastoid) are common recording sites for non inverting and inverting electrodeds, respectively. Thus, if the vertex electrode lead is plugged into the -input, the potential which is positive at the vertax relative to the ear to be lobe will be represented as an upward deflection on the oscilloscope. This situation is referred to as "vertex positive and up" If the vertex electrode is plugged into the negative input and the ear lobe electrode into the positive input, a potential which is positive at the vertex relative to the earlobe willbe represented as a downward deflection. This situation is refferred to as vertex positive down.

(viii) Recording mortage

Various sites for placement of the non inverting inverting and common electrode have been reported. The vertex site is commonly employed for the non inverting electrode. Several investigators have reported that movement away from the vertex by 6-10 cm away in any direction has essentially no effect on the brainstem auditory evoked responses. Some investigators have recommended upper middle part of the forehead, because of the ease of electrode placement and non-interference of the head band of the ear phones.

The inverting electrode is commonly placed on the mastoid or earlobe ipsilateral to be ear receiving the stimuli, the ipsilateral neck, or on the spine of seventh cervical vertebra.

Berlin (1979) demonstrated that wave I is augmented by mastoid placement where as, wave is enhanced by cervical placement.

Stockwell et al (1978) wave I is enhanced with placement on the medial surface of the ear lobe compared with other periaural recording sites such as mastoid. Typical electrode locations for the common electrode include the mastoid, earlobe, or neck on the side contralateral to the ear receiving the stimuli or on the forehead.

Beattie et.al., (1986) evaluated the effect of electrode placement on the amplitude and latencies of the ABR waves when a alternating click of 70 dB nHL was presaented to young adults. Ten electrode combinations were evaluated. The non inverting electrode was placed on the vertex for half of the subjects. The locations for placement of inverting electrode included the ipsilateral mastoid, the ipsilateral neck or the seventh cervical vertebra. The

various locations for the placement of common electrode included the contralateral mastoid, lower forehead, and the contralateral side of neck.

Results: **1.**. These electrode placement did not significantly affect the latencies of wave I, III and V .

2. However the amplitudes of the ABR waves were affected.

(ix) Two channel recordings

Simultaneous ipsilateral and contralateral (Two channel) recordings using the vertex as the non inverting site, the ipsilateral and contralateral mastoids/earlobes as the inverting site can facilitate identification of peaks with the contralateral recording Peak I and III are reduced in amplitude the II - III IPL is is shortened and the I - V IPL, the IV - V IPL and wave V peak latency are increased with contralateral recording as compared to ipsilateral recording.

The increased IV - V IPL is the contralateral recording helps to resolve wave V in the recording since wave IV and V may be difficult to identify in the ipsilateral recording derivation.

(x) Ipsilateral Masking

Burkard and Hecox (1983 a) investigated the effect of ipsilateral broadband noise masking on latency and amplitude of click evoked ABR. They found that the wave V amplitude decreased as a function of Ipsilateral noise level above approximately 20 dB EML for click intensities between 20 dB and 60 dB nHL. The wave V latency also increased under similar conditions as above.

(xi) Contralateral Masking

Chiappa et.al., (1979) obtained findings that contradicted the findings that contralateral masking was unnecessary in ABR assessment. They recorded the ABR from a few patients with unilateral problem and hearing impairment. The ABR were present when the poorer ear was stimulated, but were abolished with Broad band noise masking into the nontest ers at 60 dBSL. The contralateral masker did not affect the latencies or amplitudes of the ABR components in normal listeners, although in several subjects, the contralateral masking resulted in a change in wave form morphology.

(xii) Binaural Stimulation

In binaural stimulation, clicks are presented simultaneously to both ears and the responses recorded monoaurally. Binaural stimulation results in increased amplitude of the later waves at all intensities, since binaural stimulation increases the amplitude of wave V but not wave I, theV/I ratio is increased with binaural as compared with monoaural stimulation.

Subject Parameter

(I) Gender

The latencies of male adults exceed those of females. This effect was attributed to differences in brainstem size, length of external auditory meatus and diameter of auditory nerve.

On an average the wave V peak latencies is approximately 0.2 ms shorter and the wave V amplitude is approximately 25% larger in females than in males.

(ii) **Drags**

It has been reported that sedation does not affect the ABR. In fact sedatives such as chloral hydrate, secoborbital, and DTP (Dermal, phenargen and Thorazine) reduce the muscular artifact, thereby enhancing the Brainwaves. Since anaesthesia has little effect on the ABR waves it has been used extensively in intraoperative monitering.

(iii) Temperature

The ABR may be affected when increased body is induced in patients suspected of having multiple sclerosis.

Body temperature do not affect the Brain unless it drops below 86° C the effect of temperature needs to be considered only during special surgical procedures and coma and during intoxication cases.

Inter peak latencies lengthen when ABR is recorded intraoperatively when the person is subjected to temperatures of about 28 - 32° C.

(iv) **AGE**

The peak latencies and the I - III inter peak latency increased with age.

Peak V latency increases by approximately 0.1 ms per decade.

Clinical Application of ABR

The auditory system as well as the nerve function is checked and hence ABR provides information on both impairments of hearing (audiologic) as wella as disorders of neural function (neurologic)

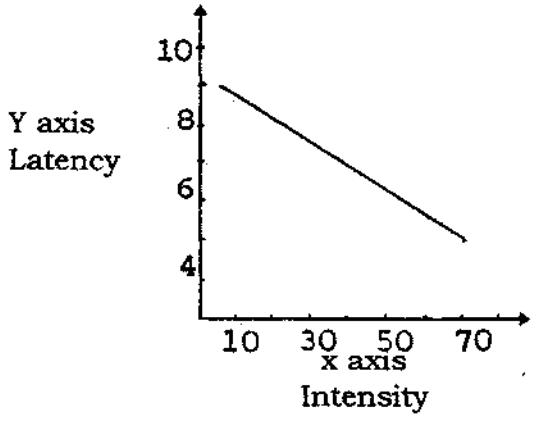
Audiological application

The hearing thresholds can be determined at about 10-20 dBSL wave V can be identified. Hence threshold will be the onest intensity at which wave V is identifiable minus 10 or 20 dB In new borns as young as 33 weeks of gestational age the hearing threshold can be Sound. ABR threshold elicited by click stimuli correlates best with the audiometric less between 1 KHz and 4kHz.

Predictions of conductive hearing loss from ABR thresholds have a greater likelihood of being accurate than predictive accuracy suffers as the audiometric configuration of sensorineural impairment steepens.

Site of lesion

It can be found by simply plotting the V^{th} wave intensity - latency function which is a graph with intensity period on X axis and latency on the Y axis. In a normal hearing subject the wave V intensity latency function looks like this.



The normal adult scope function is about 0.04 ms/dB with a range of 0.03 (0.06 ms/dB conductive loss reduces the effective stimulus energy reaching the cochlea(i.e.,) when a 60 dB nHL click is used to elicit an ABR

in a patient having a 40 dB conductive hearing loss, only 20 dB reaches the cochlea therefore the response latency corresponds to the normal value for a 20 dB nHL click stimulus. As stimulus intensity is reduced from 60 dB nHL latency remains prolonged by an amount related to the 40 dB loss. Consequently the patients intensity latency function for a given ABR wave would be parallel to the normal function but displaced in time. This can also be seen in retro cochlear conditions. The intensity latency function in cochlear hearing loss is different from that of conductive loss. The steep slope may be due to recruitment. The intensity latency function in retrocochlear hearing loss is similar to that of conductive hearing loss, A slope function greater than 0.06 ms/dB is indicative of senorineural pathology. The interwave latency of V - I and III - I is prolonged in ears with retrocochlear pathology. The amplitude ratio of wave V/wave I, is less than one.

Slope function less than 0.03 ms/dB or less suggests primarily high frequency hearing loss.

Neurological Application

1) To assess the maturation of the auditory pathway in premature infants and neonates.
2) Check the neurological integrity in some paediatric population.
3) Detecting 8th nerve and low brainstem lesions
4) Detection of multiple sclerosis and other demyelinating diseases.
5) In intra operative monitoring.

6) Monitoring neurological status of comatose patient

7) Determining brain death.

Passes the maturation of the auditory pathway in premature infants and neonates

The auditory brainstem response in infants and the neonates are different from that of adults.

ABR begins to appear similar to that of adults at 12 months of age. At high intensity a relatively an amplitude response is seen in preterm infants of 27 to 28 week of conceptional age. Wave may not be seen until after 30 weeks of conceptional age also. Wave I appears around this time and is most prominent. The amplitude of wave I doubles during the first 1 to 2 weeks and plateaus off at 3 months of age and decreases throughout adult hood.

Wave V makes its appearance only by 32 weeks of conceptional age and the peak amplitude is not reached until 12 months of age. The largest wave amplitudes are seen in infants the smallest in neonates and those of adults are in between. The latencies in neonates and preterm infants are prolonged and it decreases with age.

Wave I reaches adult values by 2 - 3 months and wave V by 1 to 2 years of age.

Wave III follows maturational schedule of wave V and Wave II and IV that of wave I and V respectively.

The inter peak latencies reflect the integrity of the central auditory system and when assessed overtime documents maturation.

ABR parameters namely the wave morphology amplitude and latency assess the maturation of the auditory pathway in premature infants and neonates.

Check the neurological integrity in some paediatric population

ABR aids not only in assessing the integrity at the auditory pathway but also the neurological integrity in some paediatric population as those suffering from infectious diseases, tumous (of the cerebropontine angle, intrinsic brainstem, supra-pineal region, cerebellum and from the suprathalamic masses) asphyxia, toxic metabolic disorders, neurodegenerative disorders, traumas in closed head injuries, chromosomal disorders and structural malformations, autism etc.

In all the above conditions the recorded ABR is abnormal in one or the other of its parameters.

Detecting 8th nerve and low brain stem lesions

ABR has high detection rate for eighth nerve and low brainstemlesion.

The interwave latency of I - V is greater than the normal mean value.

The absolute latency of wave V is prolonged in retrocochlear lesions.

Interaural latency difference also increases (ie) its greater than 0.4ms.

In case of acoustic neuromas absence of all waves are noticed.

Retrocochlear lesions have shown amplitude ratio of wave V/ wave I less than one.

Significant wave V latency shifts or degradation of wave V morphology at high repetition rates in 8th nerve or brainstem lesions.

Detection of multiple sclerosis and other demyelinating diseases:

ABR can be used in the detection of multiple sclerosis and other demyelinating diseases.

Considerable variablity in ABR abnormalities have been observed in multiple sclerosis patients.

These includes abnormality of symetry, delay in latency, Fragmented response, decreased amplitude or absence of peaks, poor response reliability abnormal responses to change in rate and abnormal latency - Intensity function.

ABR has been useful in diagnosis, in evaluating the effectiveness of therapeutic measures and in predicting the course of multiple sclerosis.

In intraoperative monitoring

ABR is a sensitive measure of the lower auditory pathway and therefore, it may be used to monitor the integrity of the lower auditory pathway and changes in hearing sensitivity during operations which may damage the inner ear, 8th nerve or the auditory centres in the brainstem. ABR is also a sensitive indicator of the condition of the brainstem and hence inference on the neurological status of the brainstem during operations.

Monitoring neurological status of comatose patients

ABR assessment and monitoring in comatose brain injured persons include neurological deterioration chemical paralysis, barbiturate coma, determination of brain death, hypoxic episodes without increased intracranial pressure etc.

A normal ABR may indicate good neurological/cognative outcome in comatose patients.

Determining brain death

ABR can be used in determining brain death. Its found that typically only wave I is obtained in cases of brain death.

ABR with multiply handicapped children and adults

Downs syndrome - These individuals have significantly shorter latencies (especially wave I) Smaller amplitudes (especially of waves II and III and reduction in intrerwave latencies especially of I - V due to selective shortening of I - II and III - V intervals.

Infantile autism:

ABR in autistic children in general show significantly longer latencies and central conduction times besides showing other variations.

Many of the multiply handicapped children (including deaf-blind) who may appear deaf and are labelled so may not actually be hearing impaired. ABR has been found useful to clear such discrepancies.

Similarly infants with infantile spasms may indicate hearing impairment but not so by the ABRs.

In children with hydrocephalous ABR can be used to document unsuspected brainstem pathology that may accompany hydrocephalus. The unsuspected brainstem pathology that may in turn complicate the assessment of hearing sensitivity in these patients.

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