BERA

- No other test than a nicely performed PTA can tell exact hearing threshold.
- BERA = BSER

**HELPS IN:**

1. Detection and quantification of deafness in the difficult to test patients like infants and mentally retarded or malingering subjects
2. Sensory or neural
3. In retro cochlear (from spiral ganglion of the cochlear nerve to midbrain ie inferior colliculus) also site of lesion.
4. Study of central auditory disorders

**AUDITORY PATHWAY** - Spiral Ganglion in cochlea $\rightarrow$ Ventral and dorsal cochlear nuclei in brainstem $\rightarrow$ superior olivary complex in midbrain $\rightarrow$ Lateral Lemniceus (midbrain) $\rightarrow$ Inferior Colliculus (midbrain) $\rightarrow$ Medial geniculate body of the thalamus $\rightarrow$ auditory cortex

- SG $\rightarrow$ V&D $\rightarrow$ SOC $\rightarrow$ LL $\rightarrow$ Inf C $\rightarrow$ MGB $\rightarrow$ Auditory cortex

**Surface electrode on vertex of the scalp, on graphic recording this electrical activity presents a wave form.**

- The process of measuring the electrical activity in the brain in response to a sound stimuli is complex.
- EEG refers to recording the random electrical activity going on in brain.
- Sound evoked electrical activity is **time specific** and occurs at a fixed point of time after sound stimulation whereas random activity (EEG) occurs at random.
- A number of responses called auditory evoked potentials can be recorded, evoked transient response can be recorded upto 500 milliseconds, the auditory evoked potential for the first 10 millisecond called Short Latency Response (SLR) only is more imp (SLR = BERA = BSER)
- SLR records the auditory evoked potential when auditory stimulus traversing through brain stem.
- **SLR - < 10 milliseconds, MLR(middle latency) - 10 - 50 ms , LLR(late latency) - 50 - 500 ms post stimulus time.**
- First 5 to 7 waves and SNP = Slow negative potential and FFR = Frequency following response are important in BERA.
- **Unlike BERA, MLR is affected by sleep as well as anaesthesia.**
- The short latency response SLR can give us an estimate of the approximate hearing threshold in 2000 to 4000 Hz range but fail to provide us any information of the hearing level in the low frequency range 250 - 500 Hz.
- **So Low frequency range can be measured by MLR and important to measure for fitting hearing aids and rehabilitation in deaf child.**
- MLR used for audiological and not neurological diagnosis (wave peaks are not only neurogenic but also myogenic).
- Abnormalities in MLR indicates disorder in thalamocortical region
- MLR is elicited by tone pips rather than clicks like BERA.
A 40 Hz SSP (steady state potential) is an electrical activity believed to be caused by superimposition of BERA waves and some of the MLR waves. Can be achieved by sound stimuli of 500 Hz of 15 millisecond duration with 40 stimuli per second. Useful for determination of hearing threshold and indicates a state of arousal.

- ASSR = SSP = Auditory steady state response is same as steady state potential
- CERA = Cortical evoked response audiometry = LLR (late latency response)
- 5 peaks - P1, N1, P2, N2, P3 (p is positive and n is negative)
- P3 ie P300 ie peak appearing at 300 ms is most imp in LLR
- Tone pips of 1000 to 2000 Hz
- In BERA around 2000 sound stimuli whereas in LLR only 50 sound stimuli
- P300 wave peak is very important clinically as this wave appears only when subject attends to stimulus or if the stimulus has some meaning for the subject.
- Usually occurs btw 300 - 500 ms (340 usually)
- It is dependent on cognitive and perceptive functions of brain.
- LLR waves are very important for neuropsychiatrists as all these waves are related to concentration and intelligence.
- Most waves generated from secondary or tertiary connections of auditory cortex.
- N1 and P2 are generated in temporal lobe cortex, P300 from limbic system (mainly hippocampus and amygdala)
- As of now the frontal, parietal, temporal cortex, hippocampus and thalamus together have been implicated in generation of P300.
- N1 related to attention, N2 related to cognitive func., P300 to cog func, concentration and intelligence.
- LLR can diagnose Schizophrenia, Alzheimers, Autism etc.

**BERA**

- Click Stimulus 50 to 60 dB above Pure tone hearing level. Frequency 40 per second
- **Active electrode** on Vertex
- **Reference electrode** on ipsilateral Mastoid or ear lobe.
- **Ground electrode** placed on other mastoid or just above nasion (forehead)
- Patient preferably asleep (mentally and physically relaxed)
- Room should have good earthing and should be away from heavy wiring or electrical equipments
- Frequency of muscular electrical artifact is between 30 to 400 Hz.
- Newer BERA instruments are available where miniature evoked potential amplifiers are placed in situ on the BERA electrodes themselves (such that extra noises like radiofrequency, electrical noise, electromagnetic field induced noise) are not picked.
- Wherever possible a puretone audiogram should be done before BERA
- The sound stimulus for BERA is a broad band click of 100 micro seconds (0.1 millisecond)
- We want rapid onset and rapid fall of sound so clicks used as pure tones are slow.
- ‘Cochlear transport time’
- Less for high fq sound
- High for low fq sound
- Clicks to ear to be tested and contralateral ear masked by white noise
- Before click is delivered to test ear it is filtered in such a way that that the lowest frequency of sounds in the broad band click is 100-150 Hz and highest frequency is 3000 to 4000 Hz.
- Click frequency should be 10 to 40 clicks per second.
- Recording obtained as a graph for time and amplitude (y)
- 5 to 7 waves obtained in first 10 ms
- 5 prominent and 2 small peaks
- VI and VII inconspicuous may be from Neural generators.

**WAVE V**

- Wave V most easily identifiable, sharp negative deflection immediately after peak
- Usually appears at 5.6 to 5.85 ms
- Largest and most robust of all waves.
- WAVE IV
- Peak just preceding wave V
- Sometimes superimposed
- Present clearly only in 50 to 60 percent of subjects
- Wave III before Wave IV just beyond 3ms mark.
- Wave II has latency of 2.8ms
- Wave I (just beyond 1 ms) gives idea that stimulus has reached cochlea. If I present rest absent means wave is no further processed after cochlea.

**INTERPRETATION OF GRAPH**

In terms of

- Absolute latency delay
- Interwave latency delay
- Latency / intensity function
- Absence of expected wave
- Deformities of wave
- Wave amplitude
- Threshold of wave V

**Upper limits of normal Values**

- Latency of wave V – 5.9 ms
- I – V latency – 4.4 ms
- I – V interaural difference – 0.29 ms
NON CLINICAL FACTORS AFFECTING BERA

- Stimulus Rate (normal 10 to 40 clicks per second)
- Stimulus phase (condensation or rarefraction)
- Intensity of stimulus
- Binaural / monaural stimulation (monaural recommended)
- Placement of electrodes
- Nature of sound used (clicks preferred)
- Sex (females have shorter latency period)
- Age (<2ys or >65yrs longer latency)

USES

- Hearing threshold via SSP (steady state potential) or substracting 10 dB from point at which wave V was just identifiable
- Nature of Deafness
- Level of Lesion
- Children and mentally handicapped, mentally ill, malingerers, unconscious
- Acoustic neuroma detection

DIADVANTAGES

- No standardization
- Wave I not easily identifiable
- Latency of V changes according to age sex.
- Wave V not recordable if hearing threshold is 75dB at 3kh
- High frequency purely cochlear lesion might mimic a neural lesion in BERA
- Low frequency lesion BERA is bad to pick up as amplitude may not be low as latencies not delayed eg in acoustic neuroma. (<1cm size always missed by BERA)

***************** BASAL COILS HIGH FREQUENCY AND APICAL LOW *****************