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Original Research Article

Auditory Brainstem Response Results in Normal-Hearing Patients with Tinnitus

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ABSTRACT

The definition is "The perception of sound that results exclusively from activity within the central nervous system without any corresponding mechanical, vibratory activity within the cochlea, and not related to external stimulation of any kind. This study presents the findings of ABR in tinnitus patients having normal hearing sensitivity in both ears. This aim of this study was to see any abnormality in neural conduction in auditory brainstem in tinnitus patients having normal hearing. This study included 25 subjects having normal hearing with tinnitus complain in both ear. All were submitted to full audiological history taking, otological examination, basic audiological evaluation and Auditory brainstem response audiometry (ABR) which was recorded in both ears followed by calculation of the absolute latencies of wave I, III and V, as well as interpeak latencies (I-III, III-V, I-V). Some tinnitus patients showed significant prolonged absolute latencies of I, III (p=0.001) and interpeak latencies I-III, III-V and I-V in left ear (p= 0.001) and absolute latencies of I, V (p=0.001), interpeak latencies III-V was statistically significant in right ear. The prolonged absolute latencies and IPLs suggests abnormal neural firing synchronization or in transmission in the auditory pathways in normal hearing tinnitus patients.

Keywords: Tinnitus, Auditory brainstem response audiometry, Absolute latency, Interpeak latency.

INTRODUCTION

Tinnitus is a common and persistent symptom. The pathogenesis and site of origin have yet to be clearly established. It is often a characteristics of ear disease usually associated with hearing loss, but it may also occur in patients with normal hearing. [1] It is observed that the sustained plastic changes and aberrant activity residing in the sub cortical and cortical structures of the auditory and non-auditory nervous systems that cause the sensation and problem of tinnitus. [2,3]

Until the early 1980s, it was believed that tinnitus was a phenomenon which only occurs in the cochlea only. Later studies showed that such symptom may involve not only the cochlea, but also the auditory pathways and the cerebral cortex. [4] Attempts have been made to understand tinnitus and to investigate its background by means of auditory evoked potentials (AEPs). Those potentials are used to examine the

synchronous discharge of fibers in the auditory pathway and identify the presence of abnormal neuronal activity. Long latency AEPs (P1, N1, P2 and P3) studies revealed abnormal response in tinnitus patients. [2,5]

Recently, an auditory evoked magnetic field study taking a different approach reported significant differences in cortical frequency organization and positron emission tomographic (PET) study described abnormally asymmetric activity in the auditory cortices of tinnitus subjects. [6] Thus, auditory brainstem response audiometry may give information to clarify tinnitus origin and it can give the management strategies. This study aimed to evaluate any abnormality in neural conduction in auditory pathway, using ABR in middle-aged normal hearing tinnitus patients.

MATERIALS AND METHODS

Patients were selected from the ENT OPD of Pt. JNM Medical College and hospital. This study included 25 patients. Their age ranged from 25 to 40 years where mean age was 37.72yrs (SD: ± 6.64) for control group and mean age 36.64yrs (SD:± 3.51) for experimental group. All were diagnosed as having tinnitus in both ears.

The inclusion criteria: Adults less than 40 years with bilateral normal peripheral hearing and normal middle ear function, absence of any past history of otological, psychological or neurological problems.

The exclusion criteria: Patients with hearing loss or more than 40 years of age(Avoid age related hearing loss), history of otological, psychological, neurological problems, history of systemic disease (such as diabetes or hypertension) or cardiovascular diseases, patients with noise exposure, acoustic trauma or previous ototoxic medication.

Immitance audiometry and Pure tone audiometric findings:

All patients were tested for otologic examination, basic audiologic evaluation (pure tone audiometry and immittance audiometry). All patients showed "A" type tympanogram in both ears. Those patient shows other type of tympanogarm were excluded from this study. In PTA, Warble tone was used in pure tone audiometry testing (Better distinguishing the tone). All patients showed normal hearing sensitivity in both ears. (Table: 1)

Table-1 Pure-tone audiometry threshold.

Frequency in Hz	Tinnitus patients		Control group	
	Left ear (Mean ± SD)	Right ear (Mean ± SD)	Left ear (Mean ± SD)	Right ear (Mean ± SD)
250	17.00±3.81	17.00±3.22	16.80± 3.78	17.40±3.22
500	16.40±3.68	18.20±2.44	16.60±3.45	17.40±2.54
1000	15.00±4.08	16.20±3.61	16.00±3.81	16.80±3.18
2000	17.60±3.26	16.00±3.81	16.60±3.45	16.60±3.13
4000	18.40±2.78	15.80±4.49	18.00±3.22	15.40±3.79
6000	19.60±3.20	17.80±2.53	19.00±3.05	16.60±4.01
8000	18.60±3.25	20.20±3.37	19.00±3.20	20.40±4.06

Auditory brainstem response audiometry (ABR) was done using Smart-EPs of Intelligent Hearing System (IHS). This was done through two-channel recording using four disposable electrodes applied according to the Smart-EP manual specification as the following sites:. Non-inverting electrode (+): Vertex (Cz). Inverting electrode (-): Test ear mastoid (A1/A2) Ground Electrode: Fore head (Fz). All electrodes were connected to the pre-amplifier of the Smart-EP equipment. ABR

was recorded ipsilaterally in response to click stimuli presented at 70 dBnHL using rarefaction polarity with 21.1/s repetition rate. Stimuli were delivered via ER3A-insertphone. The absolute latencies of wave I, III and V, interpeak latencies (IPLs) I–III, III–V and I–V were calculated. Statistical analysis was done using SPSS-20. Paired Sample *t*-test was used compare between ABR results (absolute latencies, IPLs) between both groups.

Table-2 Acquisition parameters of ABR

Type of stimulus	Clicks
Number of sweeps	2000
Stimulus intensity	70dBnHL
Filter setting	100-3000Hz
Analysis window	12ms
Repetition rate	21.1
polarity	Rarefaction
Amplifier gain	100.0K
Electrode Montage	Non-inverting electrode (+): Vertex (Cz). Inverting electrode (-): Test ear mastoid (A1/A2) Ground Electrode: Fore head (Fz)
Transducer	Insert receiver (EAR 3A)

Table 3: Absolute and interpeak latencies (in msec) in Tinnitus patient and control group (left ear)

ABR Latencies (ms)	Tinnitus patients (Mean SD)	Control Group (Mean SD)	P-Value
Wave I	1.37 ±0.05	1.35 ±0.07	0.001*
Wave III	3.38 ±0.10	3.33 ±0.09	0.001*
Wave V	5.80 ±0.09	5.50 ±0.09	0.16
I-III	2.01 ±0.10	1.98 ±0.11	0.001*
III-V	2.41 ±0.16	2.17 ±0.14	0.001*
I-V	4.43 ±0.12	4.15 ±0.11	0.03

* indicates significant at p<.05.

Table 4: Absolute and interpeak latencies (in msec) in tinnitus patients and control group (right ear)

ABR Latencies (ms)	Tinnitus Patients (Mean SD)	Control Group (Mean SD)	P-Value
Wave I	1.48±0.08	1.36± 0.06	0.001*
Wave III	3.64±0.05	3.33±0.06	0.796
Wave V	5.85±0.07	5.4±0.09	0.002*
I-III	2.16±0.11	1.96±0.10	0.090
III-V	2.21±0.07	2.13±0.12	0.001*
I-V	4.37±0.11	4.09±0.10	0.065

* indicates significant at p<.05.

RESULTS

In Pure-tone audiometry, the hearing thresholds were normal at all frequency in both tinnitus and control group (Tabel-1).

In ABR the absolute and interpeak latencies of wave I, III, V and I-III, III-V, I-V were investigated separately in both ears for each patient. Different values were taken for the right as well as left ear. ABR results of left ear for all patients and control group are shown in Table 3. It can be concluded that tinnitus patient have significantly delayed absolute latencies of I and III (P = 0.001) and interpeak latencies I-III, III-V, I-V (P=0.001) as compare to control group.ABR results of right ear for all patients in tinnitus and control group are shown in Table 4. The absolute latencies I, V have significantly delayed (P= 0.001), but wave III was not significant (P= 0.079). For interpeak latencies there was significant of Wave III-V (P = 0.001) but there was no significant statistical difference between wave I-III & I-V.

DISCUSSION

Tinnitus is an often devastating symptom of auditory system disorders. The sensation of tinnitus may be associated with the perceptual impairments at various levels of the auditory processing. Since there is a common agreement that tinnitus can be also due to an impaired brain process, many researchers tried to support this assumption with electrophysiological evidences. [7]

In this work, ABR was used to evaluate the auditory pathway at the brainstem level. There was significant difference found in absolute I and III (P = 0.001) and interpeak latencies I-III, III-V, I-V (P= 0.001) in left ear and only absolute latencies I and V (P= 0.001) and interpeak III-V (P=0.001). These findings are supported by previous study conducted by Kehrle et al [1] and Rosenhall and Axelsson [8] who showed the ABR abnormality specifically two patterns of abnormalities. The first pattern was a prolongation of wave I, III and V, findings which are consistent with a lesion in the peripheral auditory

system. The other was lengthening of the IPLs reflects an increased neural conduction time in the brainstem. [9] Both patterns occurred most often in tinnitus patients with normal hearing or slight hearing loss.

In this work, the increase of IPLs III–V in right ear and I-III, III-V, I-V in left ear. Both ears have significantly prolonged interpeak latencies III-V (P= 0.001). This may be due to abnormal activation of auditory system which will be changing the central transmission at particularly upper brain stem regions. These findings are partly supported by P. J Jastreboff. [10] These similarity ABR results could be related to brainstem regions with perceived tinnitus. Tinnitus is caused by abnormal spontaneous hyperactivity in the auditory pathways. [11]

Many dysfunctions of the auditory system can result spontaneous hyperactivity along the auditory pathways and that such dysfunctions like cochlear impairment and pathologic changes in any part of the auditory nerve. Additionally, abnormal activity at higher levels (cochlear nuclei, auditory cortex and association areas) is also involved in tinnitus perception. [6, 12] The efferent system also involved in tinnitus generation and contributes to ABR abnormality involving wave I and III abnormalities. [13]

CONCLUSION

ABR results in normal hearing tinnitus patients are different form control groups. The prolonged absolute latencies and IPLs suggests abnormal neural firing synchronization or in transmission in the auditory pathways in normal hearing tinnitus patients. This is very important for planning out the proper management and appropriate medication and instrumentation relief from tinnitus. The importance of ABR will help to decide the aim of rehabilitation program whether it is to restore of homeostasis of brain activity or to act at on peripheral level. Further evaluation of tinnitus patients based on severity, duration and character are recommended to provide more understanding of tinnitus problems and appropriate rehabilitation programs.

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