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Original Article

Evaluation of Latencies and Interpeak Latencies of BAEP Waves in COPD Patients

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Abstract

The present study is carried out to assess brainstem auditory evoked potentials in patients of COPDand to evaluate effects of COPD on it before any clinical signs and symptoms of auditory impairment appear. This early diagnosis will help in maintaining a better quality of life in patients of COPD.Study includes 100 individuals divided in two groups, study group (n=50) and controls (n=50). Study group consist of COPD patients those had duration of COPD for more than 5 years with stable course of disease.Latency of wave I, III, IV, Vwere prolonged in cases compared to controls in right ear and left ear.The difference is statistically significant (p value <0.05). Right ear interpeak latencies of I–III, III-V and I-V were increased with statistical significance among cases compared to controls (p value <0.05). In left ear, interpeak latencies of I-III and I-V were statistically more (p value <0.05) in case group compared to control group.The subclinical BAEP impairment in patients of COPD was due to the severity of airflow obstruction which causes chronic hypoxemia. The progressive chronic hypoxemia leads to development of tissue hypoxia and decreases the cerebral perfusion; also it slows the nerve conduction in auditory pathway which causes prolongation of latency.

Introduction

Brainstem Auditory Evoked Potential (BAEP) is a tool sensitive enough to detect sub-clinical auditory impairment. BAEP are electrical potentials recorded from scalp in response to auditory stimuli. It is a simple, non-invasive procedure to detect early impairment of acoustic and CNS pathway, even in the absence of specific symptoms. BAEP is used to assess the conduction through auditory pathway up to midbrain. The changes in BAEP have been correlated with lesions at different levels of auditory pathway.

The present study is carried out to assess brainstem auditory evoked potentials in patients of COPD and to evaluate effects of COPD on it before any clinical signs and symptoms of auditory impairment appear. This early diagnosis will help in maintaining a better quality of life in patients of COPD.

Aims & Objectives

1). To evaluate BAEP parameters in patientsof COPD and compare it with controls.

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I. Assessment of latencies of BAEP waves in right and left ear –

1) To compare latency of wave I, II, III, IV, V in COPD patients and controls.

II. Assessment of interpeak latencies (IPLs) of BAEP in right &left ear –

1) To compare IPL I-III between COPD patients and controls.

2) To compare IPL III-V between COPD patients and controls.

3) To compare IPL I-V between COPD patients and controls.

Materials and Methods

The present study was conducted in the Department of Physiology & Department of Pulmonary Medicine in Grant Government Medical College & J.J Hospital, Mumbai. Before commencement of study, approval was taken from the Institutional Ethical Committee.

The study design involved 100 individuals which can be divided in two groups. Group I – Diagnosed patients of COPD as per GOLD criteria, after applying inclusion and exclusion criteria were accepted for study (n=50). Group II – Age & sex matched normal healthy adults (n=50). The following clinical features were considered during diagnosis of COPD[10] : dyspnoea, chronic cough, chronic sputum production, history of exposure to risk factors, and family history of COPD. In addition to these signs and symptoms, spirometry was done to confirm the diagnosis of COPD and the severity of airflow limitation was determined by GOLD gradation criteria (post-bronchodilator FEV_1/FVC ratio less than 70%, consistent with airflow limitation that is not fully reversible, GOLD criteria).

GOLD gradation of COPD:[11]

Severity of Airflow limitation based on Post-Bronchodilator FEV_1 in patients of FEV_1/FVC <0.70

Severity		FEV_1 % predicted
GOLD 1	Mild	$FEV_1 \geq 80\%$ predicted
GOLD 2	Moderate	FEV_1 50–79% predicted
GOLD 3	Severe	FEV_1 30-49% predicted
GOLD 4	Very severe	$FEV_1 < 30\%$ predicted

The evaluation was done in following stages –

1) A written informed consent was taken from all participants of this study.

2) A detailed history-taking and thorough clinical examination was done.

3) Spirometric test was performed in both groups and diagnosis of COPD was confirmed in cases

4) BAEP recording was done.

Among COPD patients, those had a duration of COPD for more than 5 years with stable course of disease, having a regular follow up for 1 year with no hospitalization for COPD related illness in preceding 6 months were included in study group. All COPD patients in study were males and had smoking history. They were having moderate to severe airflow limitation. The subjects who met the criteria were selected for the study. The study and control group were selected as per inclusion and exclusion criteria. Spirometry test was done in study group with the help of MEDGRAPHICS Body Plethysmograph machine.

Inclusion criteria for selection of COPD patient –

1. Males with age group of 40-60 years.

2. On spirometric test, patients having post-Bronchodilator FEV_1% predicted valueless than 80% with FEV_1/FVC ratio <0.70.

3. Patients with normal auditory function tests.

Inclusion criteria for controls

1. Normal healthy male individuals with age group of 40-60 years.
2. Subjects having no addiction (Non-smokers).
3. Subjects having normal hearing.

Exclusion criteria for both

1. Patients of COPD in acute exacerbation.
2. Subjects having any clinical neuropathy.
3. Subjects having hearing loss.
4. Subjects suffering from another acute/chronic medical disorder like hypertension, diabetes mellitus, malignancy, leprosy, tuberculosis.
5. Subjects with history of addiction to alcohol, drug abuse.
6. Subjects with history of drug intake known to cause central neuropathy e.g. Reserpine, Phenytoin, Alphamethyldopa, Nitrofurantoin.
7. Subjects who had history of taking ototoxic drugs e.g. Gentamycin, Amikacin, Streptomycin, Kanamycin and Quinine.

Evoked Potential study[12]

Pre-test preparation –

The skin was prepared by mild abrading and degreasing by *Nu-Prep* gel. Standard cup electrodes were used. The electrodes were placed on their respective sites using electrode paste as per 10-20 international system of electrode placement. The tests were carried out in a quiet room. EMG and EP digital neurophysiological system software, Neuro-MEPw version 3.0,64.0 was used to conduct evoked potential tests.

Brainstem auditory evoked potential Recording –

All the techniques of recording, machine settings and instruments were maintained uniformly throughout the study. Patients were made to lie down comfortably on couch and were asked to close their eyes and relax. BAEPs are obtained using monaural (one ear at a time) stimulation.

Electrode placement –

Active electrodes (M_i, M_c) – over mastoid processes

Reference electrode (C_z) – at vertex

Ground electrode (F_z) – at forehead in midline

Montage consisting of the following derivations was used for BAEP recording –

Channel 1: Vertex – ipsilateral mastoid process ($C_z - M_i$)

Channel 2: Vertex – contralateral mastoid process ($C_z - M_c$)

The following machine setting was used throughout the study.

1) *Stimulus* – Monaural auditory stimulus in the form of clicks were delivered through TDH-39P headphone at a rate of 10 per second (10 Hz) with the alternating polarity. The click stimuli at an intensity 100 dB SPL was given to the stimulated ear (ipsilateral) and masking sound (white noise) of 60 dB SPL to non-stimulated, contralateral ear through the headphone. Stimulus duration was 0.1 milliseconds. Responses to 2000 click stimuli were averaged for 10 milliseconds.

2) *Filter* – Low and High band pass filter was set at 100 Hz and at 3000 Hz respectively.

3) *Impedance* – The electrode impedance was kept below 5 kΩ

The signals picked up by these electrodes were filtered, averaged, amplified and displayed on the computer monitor. Two trials of recording were done and waveforms were super-imposed to check for reproducibility.

Parameter studied: BAEP waveforms from each ear with absolute latencies of I, II, III, IV, V waves and Interpeak latencies (IPLs) of I-III, III-V, I-V were considered for comparison among COPD patients and controls.

Statistical analysis:

The results were expressed as mean and standard deviation for each variable, separately for right and left side. Unpaired (independent) t-test was used for intergroup comparisons in the healthy volunteers group and the COPD group, p-value of 0.05 or less has been considered as statistically significant.

Observations and Results

Table showed that there was statistical significant increase in right and left ear latencies of wave I, III, IV, V in cases compared to controls. There was no significant statistical difference in latency of wave II of left ear among cases and controls.

There was statistical significant increase in interpeak latencies of wave I-III, III-V and I-V in case group compared to control group in right ear.

Interpeak latencies of wave I- III, I-V of left ear were prolonged with statistical significant in case group

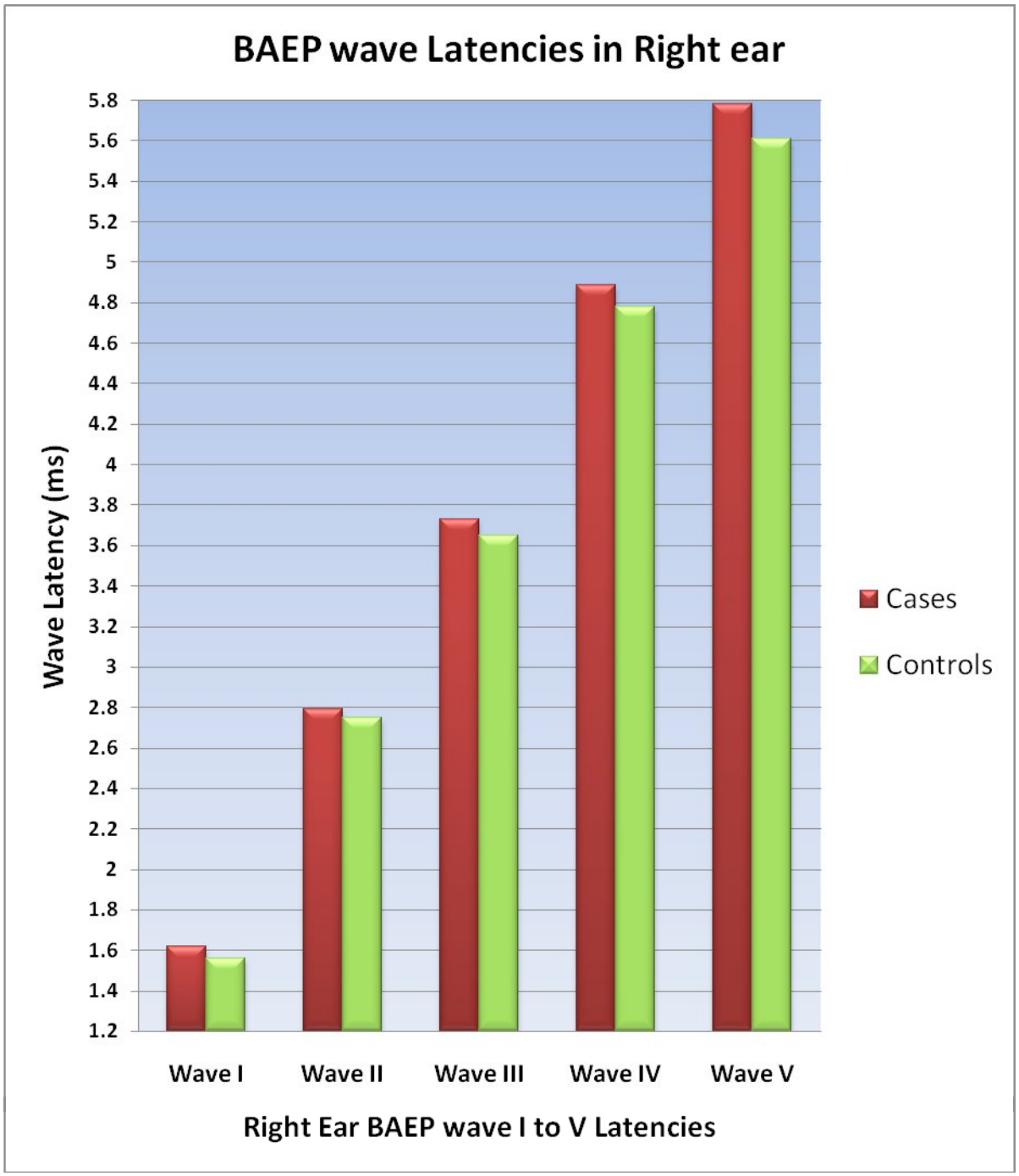
TABLE I: Table showing BAEP parameters of Right ear in case group compared to control group.

Right BAEP parameters	*Cases (Mean±S.D.)*	*Controls (Mean±S.D.)*	*p value*	
		Latency (ms)		
Wave I	1.62±0.1	1.56±0.12	0.0249	s
Wave II	2.79±0.14	2.75±0.12	0.0847	ns
Wave III	3.73±0.19	3.65±0.17	0.026	s
Wave IV	4.89±0.21	4.78±0.21	0.0164	s
Wave V	5.78±0.33	5.61±0.3	0.0091	s
		Interpeak Latency (IPLs) (ms)		
I – III	2.11±0.09	2.08±0.05	0.0466	s
III – V	2.05±0.15	1.96±0.19	0.0139	s
I – V	4.16±0.24	4.04±0.2	0.0092	s

TABLE II: Table showing comparison of BAEP parameters of Left ear in Case and Control group.

Right BAEP parameters	*Cases (Mean±S.D.)*	*Controls (Mean±S.D.)*	*p value*	
		Latency (ms)		
Wave I	1.62±0.11	1.57±0.13	0.0487	s
Wave II	2.79±0.16	2.73±0.14	0.1077	ns
Wave III	3.74±0.15	3.64±0.15	0.0024	s
Wave IV	4.9±0.18	4.81±0.24	0.0402	s
Wave V	5.72±0.29	5.58±0.26	0.0112	s
		Interpeak Latency (IPLs) (ms)		
I – III	2.11±0.04	2.08±0.03	0.0002	s
III – V	1.98±0.14	1.93±1.33	0.0931	ns
I – V	4.09±0.18	4.02±0.14	0.0236	s

p value $\geq$ 0.05 = Statistically significant
p value > 0.05 = Statistically non-significant

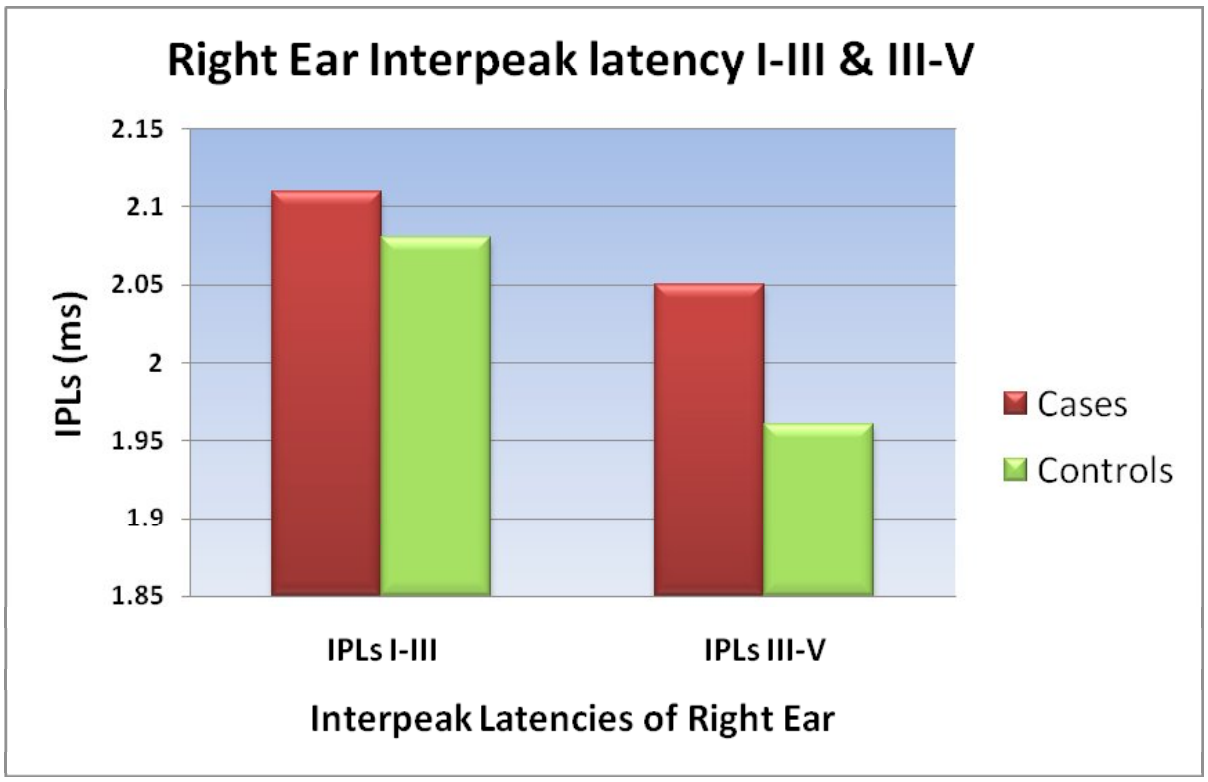


Bar diagram no. 1 : Showing comparison of Latencies of wave I, II, III, IV, V of Right ear in study group.

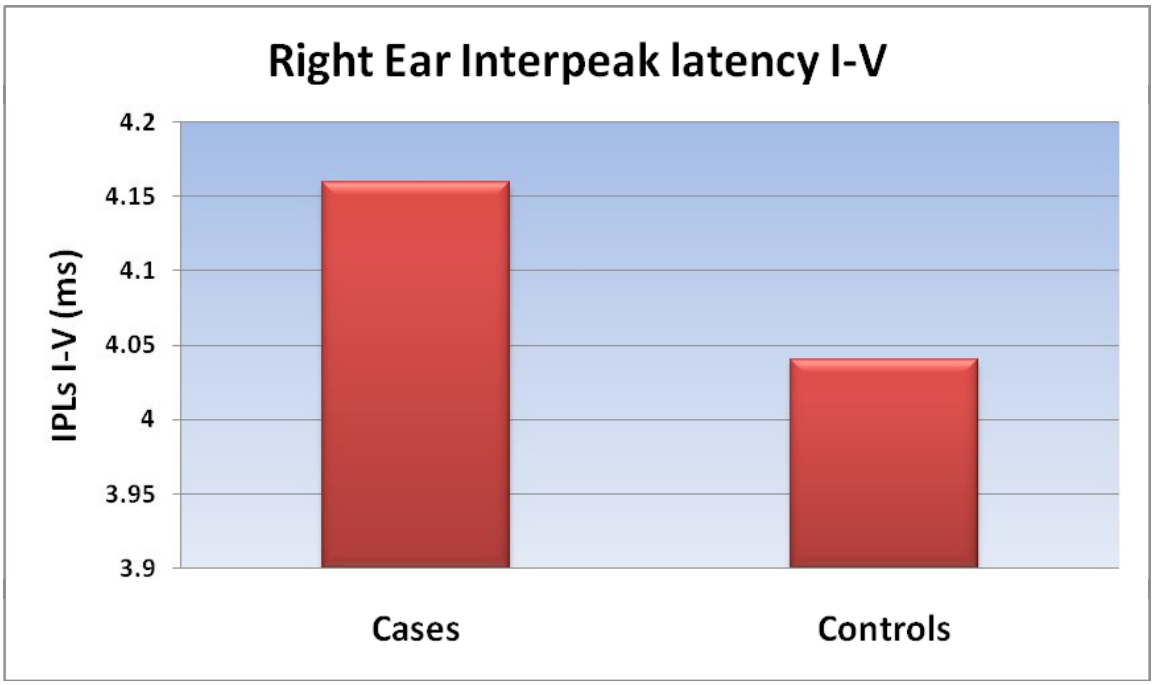
compared to control group. While left ear interpeak latency of wave III-V had no significant statistical difference in case group and control group.

Discussion

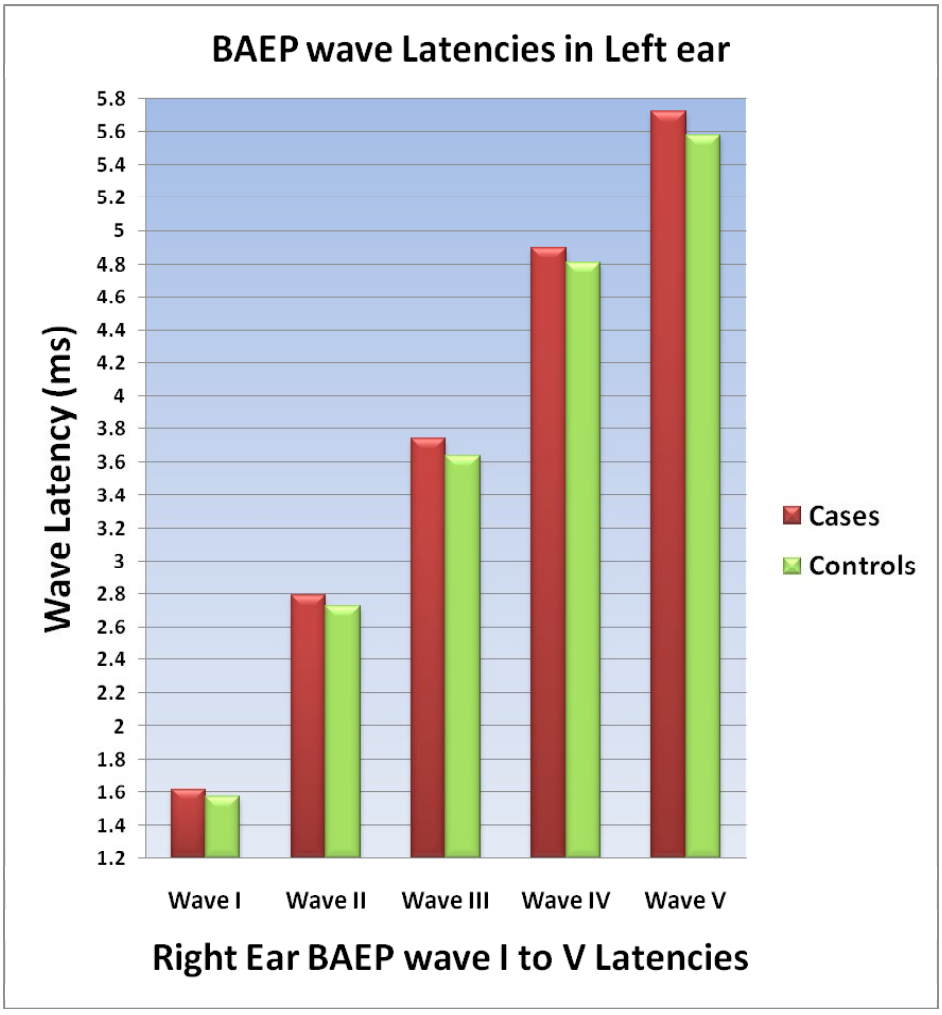
The present study showed statistically significant difference (p value <0.05) in latency of wave I, III, IV, V in study group where latencies of all these waves were prolonged in cases compared to controls in right ear and left ear. Right ear interpeak latencies of I–III, III-V and I-V were increased with statistical significance among cases compared to controls (p value <0.05). In left ear, interpeak latencies of I-III



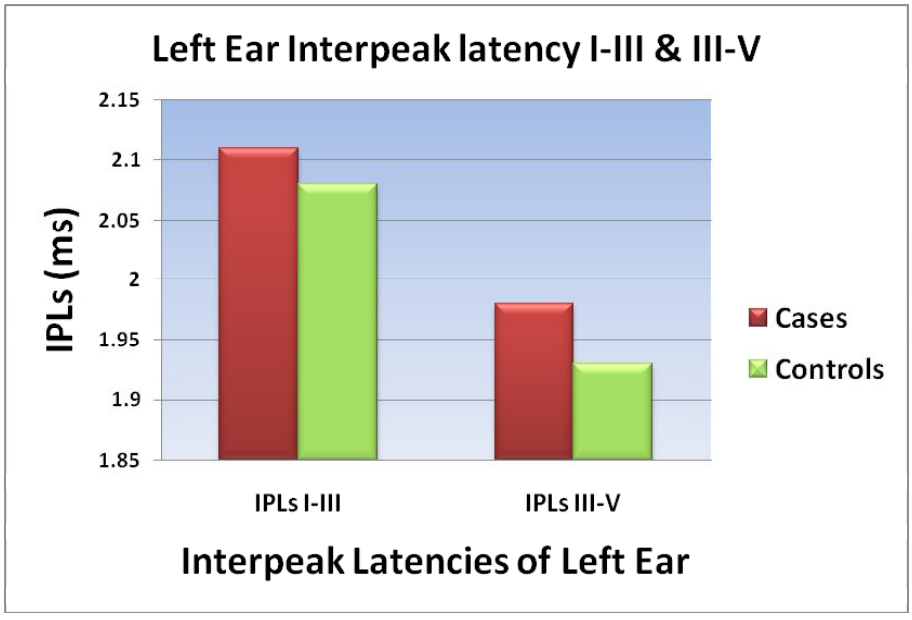
Bar diagram no. 2: Showing comparison of Interpeak latencies of wave I-III, III-V of Right ear in study group.



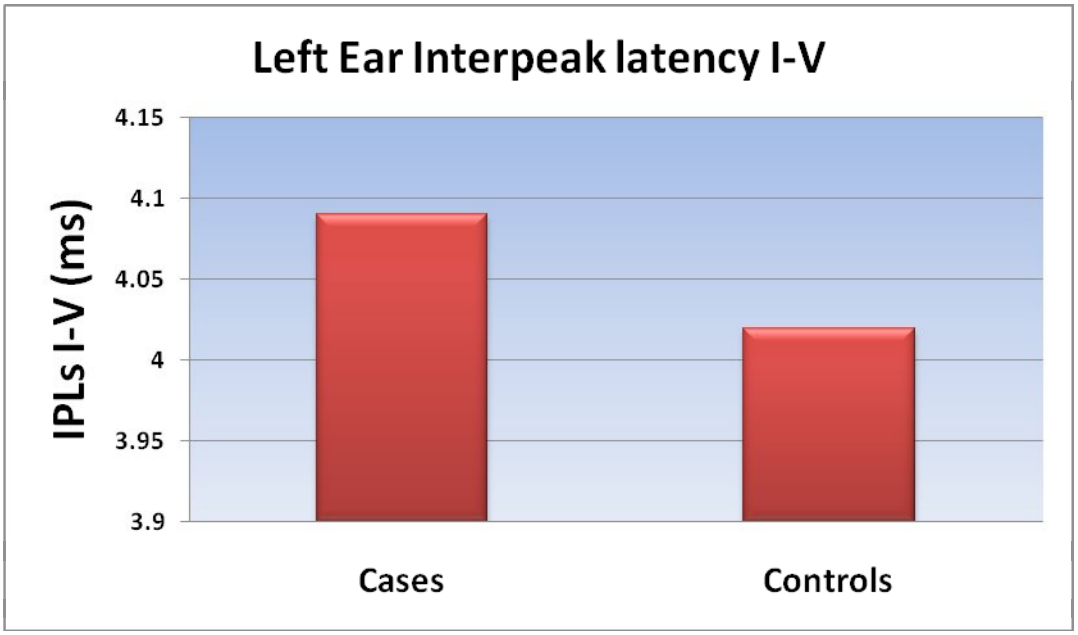
Bar diagram no. 3: Showing comparison of Right ear Interpeak latency of I-V in study group.



Bar diagram no. 4: Showing comparison of Latencies of wave I, II, III, IV, V of Left ear in study group.



Bar diagram no. 5: Showing comparison of Interpeak latencies of wave I-III, III-V of Left ear in study group.



Bar diagram no. 6: Showing comparison of Left ear Interpeak latency of I-V in study group.

and I-V were statistically more (p value <0.05) in case group compared to control group. BAEP in patients with COPD have been evaluated in previous studies, but there is great variation in study outcome. The finding of the present study is in accordance with the finding of earlier studies by *Grant et al*[13] *(1987), Atis et al*[14] *(2001), Kayacan et al*[15] *(2001), Gupta et al*[16] *(2008), Nesrien Shalabi(17) (2012), Shabina et al*[18] *(2013).*

The results of present study are different from results of *Nakano et al*[19] study. This difference may be due to different disease pattern as they studied heterogeneous groups of chest diseases with variable degree of hypoxemia.

In present study, the COPD patients were smokers and had moderate to severe airflow obstruction (stage 2, 3). The subclinical BAEP impairment in patients of COPD was due to the severity of airflow obstruction which causes chronic hypoxemia. The progressive chronic hypoxemia leads to development of tissue hypoxia and decreases the cerebral perfusion; also it slows the nerve conduction in auditory pathway which causes prolongation of latency. The contents of tobacco smoke in addition to hypoxemia lead to hypoxia. Thus all these factors related to COPD; affect functioning of auditory pathway and causes BAEP impairment.

Conclusion

The following conclusion can be drawn from this study –

The prolongation of latencies of Brainstem auditory evoked potentials in patients of COPD is due to slowing of conduction in auditory pathway which is suggestive of demyelination. The chronic airway obstruction causes hypoxemia and leads to hypoxia which decreases the cerebral perfusion.

This neurophysiological impairment represents an additional problem to physical effects of COPD. Together both will affect the quality of life in patients of COPD. BAEP are simple, non-invasive electrophysiological tests which determine the functional integrity of auditory pathway and can detect auditory impairment in patients of COPD even in the absence of clinical findings.

This study also recommends the yearly assessment of BAEP in patients of COPD so that the subclinical neuronal impairment can be detected as early as possible. It will help in improvement of quality of life of COPD patients.

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