Original article:

Evaluation of Brainstem Auditory Evoked Potentials in stable patients with COPD

1Dr.S.Palani, 2Dr.M.Sivaraj

1Assistant Professor, Department of Physiology, Govt.Kilpauk Medical College, Chennai
2Assistant Professor, Department of Physiology, Govt.Kilpauk Medical College, Chennai

Corresponding author: Dr.S.Palani, Assistant Professor, Department of Physiology, Govt. Kilpauk Medical College, Chennai - 10.

Abstract:
Introduction: Aim of our study is to evaluate Brainstem Auditory Evoked Potentials in stable patients with COPD.

Material & methods: in this study, 100 subjects were included: 50 Stable COPD patients with no clinical neuropathy; 50 age matched healthy volunteers as control groups. BAEP waves were recorded and compared in both the groups.

Results: We observed significantly prolonged latencies of waves III over right side and waves II & III over left side. We also observed significantly prolonged Interpeak latencies of I – III over right side and waves I - III over left side.

Conclusion: we observed significant BAEP abnormalities in the stable COPD patients with no clinical neuropathy.

Keywords: Chronic Obstructive Pulmonary Disease (COPD), Brainstem Evoked Response Audiometry (BERA), Brainstem Auditory Evoked Potential (BAEP)

Introduction:
Chronic obstructive pulmonary disease (COPD) is a life-threatening lung disease that interferes with normal breathing. It is a major cause of health care burden worldwide. It is characterized by airflow limitation which is irreversible and progressive. It is due to inflammatory response of the lungs to noxious gases. Brainstem auditory evoked potentials are the potentials recorded from the ear and vertex in response to brief auditory stimulation to assess the conduction through auditory pathway. This study is to evaluate BAEP abnormalities in stable COPD patients having no clinical auditory dysfunction.

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history were taken from among the staff of kilpauk medical college.
Patients with Pulmonary tuberculosis, Diabetes mellitus, Hypertension, Alcoholism, Neurological disorders, Kyphoscoliosis, Anemia, Vitamin deficiencies, Drugs causing neuropathies, Thyroid disorders, Acute severe COPD, and Bronchial asthma were excluded from the study. The study was approved by the Institutional Ethical Committee, Kilpauk Medical College. All pre-request for ethical clearance were followed.
BAEP studies were carried out on a computerized nerve conduction testing equipment: Medicaid Computerized Physiolab Neuroperfect Plus. The signals were picked by the electrodes and were filtered, amplified, averaged, displayed on the screen of the Medicaid computerized Physiolab Neuroperfect plus and recorded. The normal BAEP recordings consists of 5 or more vertex positive waves (which were labeled by roman numericals) arising within 10 ms of auditory stimulus. Latencies of waves I, II, III, IV and V together with inter Peak latencies (IPL) of I–III, I–V, III–V were measured from recordings. Any deviations from the normal values are considered as abnormal.

Statistical analysis:
Results were derived by statistical analysis of the data obtained, and expressed in tables and charts. The data were analyzed using SPSS 7.5 for windows student version software. The data were analyzed using independent samples t-test. P value <0.05 was considered significant. P value <0.01 was considered highly significant. P value <0.001 was considered very highly significant.

Results:

TABLE – 1
Comparison of age, height, weight and BMI between cases and controls

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Numbers</th>
<th>Mean</th>
<th>S.D</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Case</td>
<td>50</td>
<td>50.12</td>
<td>5.752</td>
<td>0.145</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>50</td>
<td>51.72</td>
<td>5.131</td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>Case</td>
<td>50</td>
<td>1.6986</td>
<td>0.06105</td>
<td>0.857</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>50</td>
<td>1.7008</td>
<td>0.06044</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>Case</td>
<td>50</td>
<td>69.82</td>
<td>5.185</td>
<td>0.537</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>5</td>
<td>69.20</td>
<td>4.806</td>
<td></td>
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<tr>
<td>BMI</td>
<td>Case</td>
<td>50</td>
<td>24.2106</td>
<td>1.45328</td>
<td>0.270</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>50</td>
<td>23.8828</td>
<td>1.50071</td>
<td></td>
</tr>
</tbody>
</table>

There is no significant difference between cases and controls in respect to age, height, weight and BMI.
### TABLE – 2
Comparison of BAEP waves between cases and controls

#### RIGHT SIDE

<table>
<thead>
<tr>
<th>Waves</th>
<th>Group</th>
<th>Mean</th>
<th>Std.Deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Case</td>
<td>1.7762</td>
<td>0.059792</td>
<td>0.4876</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1.7674</td>
<td>0.066327</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Case</td>
<td>2.8812</td>
<td>0.053667</td>
<td>0.3328</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.869</td>
<td>0.070545</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Case</td>
<td>4.2726</td>
<td>0.249659</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>3.9868</td>
<td>0.065167</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Case</td>
<td>5.0766</td>
<td>0.156904</td>
<td>0.6106</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>5.0608</td>
<td>0.15238</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>Case</td>
<td>5.7554</td>
<td>0.124576</td>
<td>0.5501</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>5.7388</td>
<td>0.150965</td>
<td></td>
</tr>
</tbody>
</table>

* - Significant

### TABLE – 3
Comparison of BAEP InterPeakLatency between cases and controls

#### RIGHT SIDE

<table>
<thead>
<tr>
<th>Waves</th>
<th>Group</th>
<th>Mean</th>
<th>Std.Deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I – III</td>
<td>Case</td>
<td>2.4964</td>
<td>0.260281</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.2194</td>
<td>0.10011</td>
<td></td>
</tr>
<tr>
<td>III – V</td>
<td>Case</td>
<td>1.4828</td>
<td>0.290777</td>
<td>&lt;0.002</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1.7518</td>
<td>0.141907</td>
<td></td>
</tr>
<tr>
<td>I – V</td>
<td>Case</td>
<td>3.9792</td>
<td>0.139604</td>
<td>0.7989</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>3.9712</td>
<td>0.171864</td>
<td></td>
</tr>
</tbody>
</table>

* - Significant
TABLE – 4
Comparison of BAEP waves between cases and controls

<table>
<thead>
<tr>
<th>Waves</th>
<th>Group</th>
<th>Mean</th>
<th>Std.Deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Case</td>
<td>1.7768</td>
<td>0.045376</td>
<td>0.0546</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1.7548</td>
<td>0.065846</td>
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</tr>
<tr>
<td>II</td>
<td>Case</td>
<td>2.9858</td>
<td>0.102282</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.8836</td>
<td>0.052168</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Case</td>
<td>4.1456</td>
<td>0.159081</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>3.9918</td>
<td>0.064037</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Case</td>
<td>5.0902</td>
<td>0.136971</td>
<td>0.5732</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>5.1058</td>
<td>0.139007</td>
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</tr>
<tr>
<td>V</td>
<td>Case</td>
<td>5.7674</td>
<td>0.252553</td>
<td>0.7518</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>5.754</td>
<td>0.15954</td>
<td></td>
</tr>
</tbody>
</table>

* - Significant

TABLE – 5
Comparison of BAEP InterPeakLatency between cases and controls

<table>
<thead>
<tr>
<th>Waves</th>
<th>Group</th>
<th>Mean</th>
<th>Std.Deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I – III</td>
<td>Case</td>
<td>2.3688</td>
<td>0.163366</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.2276</td>
<td>0.097845</td>
<td></td>
</tr>
<tr>
<td>III – V</td>
<td>Case</td>
<td>1.6218</td>
<td>0.121918</td>
<td>&lt;0.002</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1.7716</td>
<td>0.192389</td>
<td></td>
</tr>
<tr>
<td>I – V</td>
<td>Case</td>
<td>3.9906</td>
<td>0.251148</td>
<td>0.8398</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>3.9992</td>
<td>0.164278</td>
<td></td>
</tr>
</tbody>
</table>

* - Significant

Discussion:
This study was done to evaluate Brainstem Auditory Evoked Potential in stable patients with Chronic Obstructive Pulmonary Disease and to find out the clinical utility of BAEP as an investigating tool in diagnosing sub-clinical involvement of auditory pathway in stable patients with COPD. The outcome of this study would help for the early diagnosis of involvement of auditory pathway in COPD patients, which may help to reduce the morbidity in COPD patients.

Our study consists of a total sample size of 100 subjects which includes 50 stable COPD patients and 50 age matched healthy controls.

Table- 1 shows that there is no significant difference between cases and controls in respect to age, height, weight and BMI in our study. In our study, the mean age of the control group was 51.72 ± 5.131 years ranging from 40 to 60 years, and the
mean age of the COPD patients was 50.12 ± 5.752 years ranging from 40 to 60 years. P value is 0.145 (not statistically significant). There was no significant difference in the mean age between cases and controls.

In our study, COPD patients with duration of illness 5 years and above were selected. In our study, the mean height of the control group was 1.7008 ± 0.06044 meters. The mean height of the COPD patients was 1.6986 ± 0.06105 meters. P value is 0.857 (not statistically significant). There was no significant difference in the mean height between cases and controls. In our study, the mean weight of the control group was 69.20 ± 4.806 kg. The mean weight of the COPD patients was 69.82 ± 5.185 kg. P value is 0.537 (not statistically significant). There was no significant difference in the mean weight between cases and controls. In our study, the mean BMI of the control group was 23.8828 ± 1.50071. The mean BMI of the COPD patients was 24.2106 ± 1.45328. P value is 0.270 (not statistically significant). There was no significant difference in the mean BMI between cases and controls.

In our study, the mean value of wave I latency on the right side was 1.7762 ± 0.059792 milliseconds and 1.7674 ± 0.066327 milliseconds respectively in cases and controls. P value is 0.4876 (not statistically significant).

In our study, the mean value of wave II latency on the right side was 2.8812 ± 0.053667 milliseconds and 2.869 ± 0.070545 milliseconds respectively in cases and controls. P value is 0.3328 (not statistically significant).

In our study, the mean value of wave III latency on the right side was 4.2726 ± 0.249659 milliseconds and 3.9868 ± 0.065167 milliseconds respectively in cases and controls. P value is < 0.001 (statistically significant).

In our study, the mean value of wave IV latency on the right side was 5.0766 ± 0.156904 milliseconds and 5.0608 ± 0.15238 milliseconds respectively in cases and controls. P value is 0.6106 (not statistically significant).

In our study, the mean value of wave V latency on the right side was 5.7554 ± 0.124576 milliseconds and 5.7388 ± 0.150965 milliseconds respectively in cases and controls. P value is 0.5501 (not statistically significant).

In our study, the mean value of wave I - III latency on the right side was 2.4964 ± 0.260281 milliseconds and 2.2194 ± 0.10011 milliseconds respectively in cases and controls. P value is < 0.001 (statistically significant).

In our study, the mean value of wave III - V latency on the right side was 1.4828 ± 0.290777 milliseconds and 1.7518 ± 0.141907 milliseconds respectively in cases and controls. P value is < 0.002 (not statistically significant).

In our study, the mean value of wave I - V latency on the right side was 3.9792 ± 0.139604 milliseconds and 3.9712 ± 0.171864 milliseconds respectively in cases and controls. P value is 0.7989 (not statistically significant).

In our study, the mean value of wave I latency on the left side was 1.7768 ± 0.045376 milliseconds and 1.7548 ± 0.065846 milliseconds respectively in cases and controls. P value is 0.0546 (not statistically significant).

In our study, the mean value of wave II latency on the left side was 2.9858 ± 0.102282 milliseconds and 2.8836 ± 0.052168 milliseconds respectively in cases and controls. P value is < 0.001 (statistically significant).

In our study, the mean value of wave III latency on the left side was 4.1456 ± 0.159081 milliseconds and 3.9918 ± 0.064037 milliseconds respectively in cases and controls. P value is < 0.001 (statistically significant).
In our study, the mean value of wave IV latency on the left side was $5.0902 \pm 0.136971$ milliseconds and $5.1058 \pm 0.139007$ milliseconds respectively in cases and controls. P value is 0.5732 (not statistically significant).

In our study, the mean value of wave V latency on the left side was $5.7674 \pm 0.252553$ milliseconds and $5.754 \pm 0.15954$ milliseconds respectively in cases and controls. P value is 0.7518 (not statistically significant).

In our study, the mean value of wave I - III latency on the left side was $2.3688 \pm 0.163366$ milliseconds and $2.2276 \pm 0.097845$ milliseconds respectively in cases and controls. P value is < 0.001 (statistically significant).

In our study, the mean value of wave III - V latency on the left side was $1.6218 \pm 0.121918$ milliseconds and $1.7716 \pm 0.192389$ milliseconds respectively in cases and controls. P value is < 0.002 (not statistically significant).

In our study, the mean value of wave I - V latency on the left side was $3.9906 \pm 0.251148$ milliseconds and $3.9992 \pm 0.164278$ milliseconds respectively in cases and controls. P value is 0.7989 (not statistically significant).

To summarize, in the present study we included 50 stable COPD patients and 50 age matched healthy controls. Latencies of BAEP waves I,II,III,IV,V and Interpeak latencies (IPL) I –III, III – V, I – V were studied in both the groups. We observed significantly prolonged latencies of waves III over right side and waves II & III over left side.

We also observed significantly prolonged Interpeak latencies of I – III over right side and waves I - III over left side.

**Conclusion:**
To conclude, in the present study, we observed significant BAEP abnormalities on electrophysiological evaluation in the stable COPD patients with mild to moderate airflow obstruction and with no clinical neuropathy, which may be due to chronic hypoxemia. The reasons for the chronic hypoxemia could be disease pathology itself, tobacco smoking, drugs used in COPD like inhaled β2 agonist, inhaled anticholinergic agents, inhaled glucocorticoids, and theophylline. On the right side there is significant prolongation of absolute latencies of wave III and Interpeak latency of I – III. There is no significant difference in latencies of waves I,II,IV,V and IPL III-V, I – V between stable COPD patients and controls. On the left side there is significant prolongation of absolute latencies of wave II,III and Interpeak latency of I – III. There is no significant difference in latencies of waves I,IV,V and IPL III-V, I- V between stable COPD patients and controls. This study proves that Brainstem Auditory Evoked Potentials can be used as an investigatory tool to identify subclinical involvement of auditory pathways in stable COPD patients with mild to moderate airway obstruction. Further studies are needed to better define the reason for auditory pathway involvement in COPD patients, which may help to reduce the morbidity of COPD patients.

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