

Original Research Article

DOI: <http://dx.doi.org/10.18203/issn.2454-5929.ijohns20182400>

Audiological assessment in organophosphorous poisoning

Mahender Singh¹, R. S. Minhas¹, Prem Machhan², Ramesh Kumar Azad¹, Shobha Mohindroo^{3*}

¹Department of Otorhinolaryngology, ²Department of Medicine, ³Department of Pathology, Indira Gandhi Medical College, Shimla, Himachal Pradesh, India

Received: 18 April 2018

Revised: 21 May 2018

Accepted: 23 May 2018

*Correspondence:

Dr. Shobha Mohindroo,

E-mail: mahidr81@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Organophosphate (OP) poisoning is a common cause of significant mortality and morbidity all over the world. In Asia, OP poisoning is the most common form of fatal self harm. Previous studies have suggested hearing loss due to OP poisoning. The aim of the study was to study audiological assessment in the patients with OP poisoning.

Methods: 26 patients (age <50 years) of OP poisoning over a period of one year were included in the study following ethical approval from Institute Ethics Committee. 25 healthy subjects served as control. Each subject was subjected to brainstem evoked response audiometry (BERA) examination.

Results: 50% patients with OP poisoning were aged between 20-29 years. Male outnumbered females in the patients (M:F- 17:9) as well as controls (M:F- 17:8). Only absolute wave-v latency (ms) was statistically significantly prolonged in cases when compared with controls in both right (0.035) as well as left ears (0.048). We found no statistical significant difference in interpeak wave I-III, III-V, I-V latency of both ears in cases when compared with controls. On second assessment in the patients, we observed a statistical significant decrease in absolute wave III and V latency, and interpeak I-III interval in right ear when compared with wave latency at first assessment. In left ear on second assessment, a significant decrease in absolute wave I, III, and V latency was observed in the patients.

Conclusions: OP compounds may affect entire neural auditory pathway. Further studies with a large sample size are required for the assessment.

Keywords: Organophosphate, Brainstem evoked response audiometry

INTRODUCTION

Organophosphate (OP) poisoning is a serious problem especially among rural population (either by farmers or traders of insecticides). It is an occupational hazard. Especially among farmers, it is a social problem. Relation between deliberate OP poisoning and psychiatric illness has been demonstrated earlier.¹ Pesticide ingestion is one of the leading methods of suicide with estimated around 3 million cases, resulting in excess of 250,000 deaths.²

Emotional stress has been the most common cause of deliberate self-poisoning in young adults. Agricultural

pesticides are the most commonly substances used for self-poisoning.^{3,4} OP compounds are involved in 76% of pesticide poisoning especially in the developing countries like India.⁵ Their neuro-toxic nature can cause hearing impairment. A case report has shown permanent, bilateral hearing loss due to acute OP poisoning.⁶

Hearing loss imposes socioeconomic problems like communication difficulties, possible job loss, and stigma. Hearing loss may also increase the risk of occupational injury because of inability to hear warning signals or shouts. Several recent articles have suggested that non-poisoned pesticide applicators exposed to OPs or

pyrethroids may also sustain hearing loss.⁷⁻⁹ A case report suggested bilateral sudden deafness due to combined poisoning of malathion and methoxychlor.¹⁰ It has been suggested that OP poisoning may result in oto- and neurotoxicity.¹¹

There have been a few studies on audiological assessment in patients with OP poisoning. In Indian settings, especially in Himachal Pradesh, no such study has been conducted so far. The present study was planned to prospectively analyze the auditory functions in the patients diagnosed with OP poisoning at Department of Otorhinolaryngology-Head and Neck Surgery, IGMSC Shimla.

METHODS

A total of 26 patients (age <50 years) of OP poisoning over a period of one year from July 2016 to June 2017 were included in the study following ethical approval from Institute Ethics Committee. The study was conducted at Department of Otorhinolaryngology - Head and Neck Surgery, IGMSC Shimla. The patients who had a history of hearing loss, middle or inner ear disease and any chronic medical illness resulting in hearing impairment were excluded from the study. Twenty-five healthy subjects served as control.

Each of the subjects was subjected to brainstem evoked response audiometry (BERA) examination. Patient having consumed OP were subjected to BERA analysis. This test was carried out in the supine position, using interacoustics EPIC PLUS systems. Absolute latencies of wave I, III, and wave V and interpeak latencies of wave I-III, I-V, and III-V were measured in milliseconds. The subjects have explained the procedure and test was conducted in the supine position. The skin over the forehead, mastoid, and vertex was prepared by cleaning with spirit. Silver disc electrodes were attached to a specific site. Earphones were adjusted to patient's ears and recording was made with interacoustics EPIC PLUS system. The stimulus was given at a rate of 11.7 Chrip per seconds. The intensity level of chrip was at 90 dBnHL. 4000 sweeps was taken and frequency band filter was set at 300-3000 Hz.

Data were presented as mean±SD, frequency, or percentages as applicable. Categorical variables were analyzed by Chi-square test. Continuous variables were differentiated by using student t-test. Paired t-test was used to compare second assessment analysis among continuous variables. P<0.05 was considered significant. The analysis was performed using SPSS trial version 21.

RESULTS

We did not observe any significant difference (P=0.802) in mean age of cases (28.46±9.33) when compared with controls (29.05±7.26). 50% of the patients with OP poisoning were aged between 20-29 years. Male

outnumbered females in the patients (M:F- 17:9) as well as controls (M:F- 17:8).

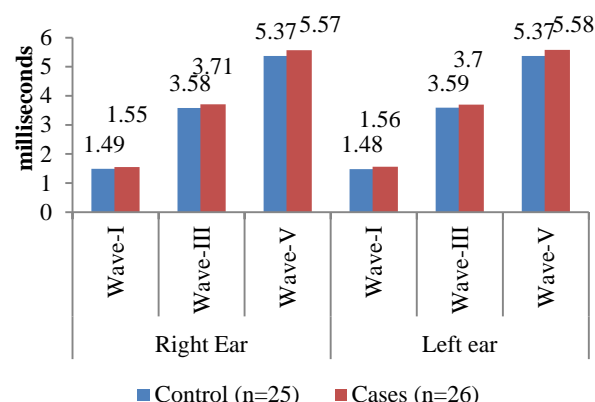


Figure 1: Absolute wave latency of right and left ear in milliseconds.

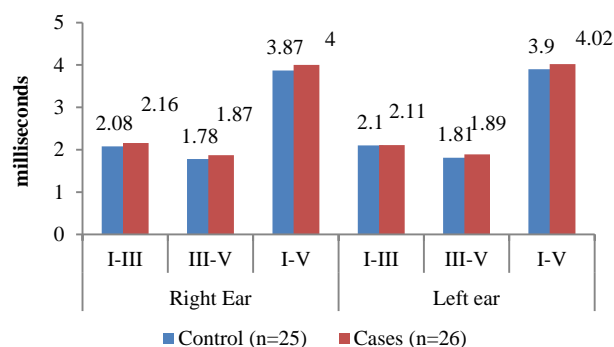


Figure 2: Interpeak wave latencies of right and left ear in milliseconds.

On BERA analysis, we found that only absolute wave-V latency (ms) was statistically significantly prolonged in cases when compared with controls in both right (0.035) as well as left ears (0.048). No significant change was observed in absolute wave I and II latency in the patients when compared with controls in both ears (Figure 1). We found no statistical significant difference in interpeak wave I-III, III-V, I-V latency of both ears in cases when compared with controls (Figure 2).

Table 1: Second assessment BERA analysis in right ear in patients (n=21).*

| Right ear | | First assessment | Second assessment | P value |
|--------------------|-------|------------------|-------------------|---------|
| Absolute latency | I | 1.56±0.239 | 1.49±0.104 | 0.192 |
| | III | 3.77±0.364 | 3.56±0.111 | 0.025* |
| | V | 5.63±0.447 | 5.43±0.212 | 0.034* |
| Interpeak interval | I-III | 2.2±0.253 | 2.06±0.121 | 0.015* |
| | III-V | 1.88±0.296 | 1.87±0.164 | 0.968 |
| | I-V | 4.06±0.387 | 3.93±0.201 | 0.065 |

*5 patients did not visit for follow-up.

Table 2: Second assessment BERA analysis in left ear (n=21).*

| Left ear | First assessment | Second assessment | P value |
|--------------|------------------|-------------------|---------|
| I | 1.55±0.231 | 1.45±0.161 | 0.047* |
| III | 3.74±0.319 | 3.57±0.163 | 0.036* |
| V | 5.63±0.457 | 5.43±0.234 | 0.044* |
| I-III | 2.17±0.247 | 2.12±0.186 | 0.367 |
| III-V | 1.87±0.231 | 1.85±0.196 | 0.796 |
| I-V | 4.06±0.486 | 3.98±0.303 | 0.334 |

*5 patients did not visit for follow-up.

On second assessment after six week in the patients, we observed a statistical significant decrease in absolute wave III and V latency, and interpeak I-III interval in right ear when compared with wave latency at first assessment (Table 1). In left ear on second assessment, when compared with wave latency at first assessment a significant decrease in absolute wave I, III, and V latency was observed in the patients (Table 2).

We also observed that there was no significant difference in absolute wave I, III, and V latency, and interpeak interval of I-III, III-V, and I-V between ICU and non ICU patients in right (Table 3) and left ears (Table 4).

Table 3: BERA analysis of right ear in ICU and non-ICU patients.

| First assessment | I | III | V | I-III | III-V | I-V |
|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Non-ICU (n=18) | 1.59±0.25 | 3.76±0.40 | 5.59±0.48 | 2.17±0.29 | 1.84±0.31 | 3.98±0.41 |
| ICU (n=8) | 1.46±0.11 | 3.59±0.16 | 5.52±0.24 | 2.13±0.19 | 1.93±0.15 | 4.06±0.26 |
| P Value | 0.172 | 0.280 | 0.732 | 0.752 | 0.427 | 0.593 |

Table 4: BERA analysis of left ear in ICU and non-ICU patients.

| First assessment | I | III | V | I-III | III-V | I-V |
|-----------------------|------------|------------|------------|-----------|------------|------------|
| Non-ICU (n=18) | 1.59±0.237 | 3.73±0.364 | 5.57±0.485 | 2.1±0.282 | 1.86±0.226 | 3.99±0.489 |
| ICU (n=8) | 1.49±0.109 | 3.64±0.158 | 5.59±0.286 | 2.15±0.21 | 1.95±0.210 | 4.1±0.36 |
| P Value | 0.311 | 0.559 | 0.876 | 0.642 | 0.352 | 0.564 |

DISCUSSION

In the present study, we observed that the most of the patients with OP poisoning were aged 20-29 years and 68% of the patients were males. In Himachal Pradesh, economy is agriculture-based and the most of the patients were farmers. 20-29 year age-group is a beginner age to practice farming in the fields where OP poisoning may occur due to easy availability. Our results have been supported by previous investigators who observed that male are more prone to suffer from OP poisoning than females.^{12,13}

Our study found that there was a significant delay in absolute latency in wave V for right and left ear in cases when compared with controls. However, no significant difference was observed in wave I and III. On second assessment, inter-peak wave latency and absolute latency compared with a first assessment, there was a significant improvement in a delay in absolute latency in right ear in wave III and V, left ear in wave I, III and V. Also significant improvement in interpeak wave latency between I-III in right ear was observed.

This finding also supported by Jaisinghe et al who observed there was a non-significant prolongation of interpeak wave latency in between I-III, III-V and I-V in the test group compared to control group.¹³ Murthy et al studied the effect of OP on the auditory pathway in 100 patients with OP poisoning.¹¹ They found that 56% of the

patients had prolonged interpeak latency in the right ear and 68% had prolonged interpeak latency in the left ear. Considering individual waves, in wave-I, 34% of the ears had prolonged absolute latency. In wave-III, 28% of the ears had prolonged absolute latency. In wave-V, 34% of the ears had prolonged absolute latency.

In our study, there was no significant difference in wave latency in patients with respiratory failure (ICU) and non-respiratory failure i.e. non ICU cases. However, Murthy et al found prolonged absolute latency of wave I, III and V and prolonged interpeak wave latency in both ears in respiratory and non-respiratory failure cases.¹¹ We also compared the effect of organophosphate toxicity on BERA with the study of Soni et al on BERA changes in bilirubin toxicity.¹⁴ They found that 10%, 13.3%, and 13.3% cases had prolonged absolute wave I, III, and V latency respectively. However, in our study, there was an increase in absolute latency of the only wave V was observed.

We also compared the results with drug-induced toxicity. Gurkov et al compared ototoxicity, tolerability, and efficacy of artemisinin-based combination therapy with that of quinine and atovaquone/proguanil in the treatment of uncomplicated falciparum malaria in a randomized controlled trial.¹⁵ There was no permanent drug-related latency prolongation in the patients with Artemether-Lumefantrine. In our study, we also observed an improvement in wave latency on follow up.

Our study results are also consistent with the drug-abuse ototoxicity studies. Weich et al suggested that with time there was an increase in absolute and interpeak wave latencies; however, the prolongation was not significant; which was consistent with our study.¹⁶ They also concluded that hearing loss is related to drug abuse; however, duration of the drug does not significantly affect the hearing loss as shown by no significant difference in absolute and interpeak latencies. Garg et al found the statistical difference of absolute latencies of waves of brainstem auditory evoked potentials (I, II, III, IV, V) of the right ear between drug abusers and controls. They also found that the difference in interpeak latency I-III was statistically highly significant, and the difference in interpeak latency I-V and III-V was statistically significant.¹⁷ In our study, prolongation of absolute latencies of wave V was observed in both the ears.

CONCLUSION

Our study showed that organophosphate may affect entire neural auditory pathway. We observed that OP poisoning may play an important role in altered auditory response in the population which improved with time. Our study also showed BERA as an important tool to determine auditory function in the patients with OP poisoning. These patients reflect the inconsistent change in BERA response which could be more clarified with studies considering a large population of the patients.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Eddleston M, Gunnell D, Karunaratne A, de Silva D, Sheriff MHR, Buckley NA. Epidemiology of intentional self-poisoning in rural Sri Lanka. *Br J Psychiatry*. 2005;187(6):583-4.
2. WHO. Pesticides are a leading suicide method. World Heal Organ. 2010. Available at: http://www.who.int/mediacentre/news/notes/2006/n_p24/en/. Accessed on 15 January, 2017.
3. Bertolote JM, Fleischmann A, Eddleston M, Gunnell D. Deaths from pesticide poisoning: a global response. *Br J Psychiatry*. 2006;189(3):201-3.
4. National Health Services (NHS) Centre for Review and Dissemination, Deliberate Self-Harm. *Eff Healthc Bull NHS Cent*. 1998;4:1-12.
5. Phillips MR, Yang G, Zhang Y, Wang L, Ji H, Zhou M. Risk factors for suicide in China: a national case-control psychological autopsy study. *Lancet*. 2002;360(9347):1728-36.
6. Emerick GL, Peccinini RG, de Oliveira GH. Organophosphorus-induced delayed neuropathy: A simple and efficient therapeutic strategy. *Toxicol Lett*. 2010;192(2):238-44.
7. Perry MJ, May JJ. Noise and Chemical Induced Hearing Loss. *J Agromedicine*. 2005;10(2):49-55.
8. Teixeira CF, Giraldo Da Silva Augusto L, Morata TC. Occupational exposure to insecticides and their effects on the auditory system. *Noise Health*. 2002;4(14):31-9.
9. Beckett WS, Chamberlain D, Hallman E, May J, Hwang SA, Gomez M, et al. Hearing conservation for farmers: source apportionment of occupational and environmental factors contributing to hearing loss. *J Occup Environ Med*. 2000;42(8):806-13.
10. Harell M, Shea J, Emmett J. Bilateral sudden deafness following combined insecticide poisoning. *Laryngoscope*. 1978;88(8):1348-51.
11. Ashok Murthy V, Visweswara Reddy YJ. Audiological Assessment in Organophosphorus Compound Poisoning. *Indian J Otolaryngol Head Neck Surg*. 2014;66(1):22-5.
12. Banday TH, Tathineni B, Desai MS, Naik V. Predictors of Morbidity and Mortality in Organophosphorus Poisoning: A Case Study in Rural Hospital in Karnataka, India. *N Am J Med Sci*. 2015;7(6):259-65.
13. Jayasinghe SS, Pathirana KD, Buckley NA. Effects of acute organophosphorus poisoning on function of peripheral nerves: a cohort study. *PLoS One*. 2012;7(11):e49405.
14. Soni A, Kanaujia SK, Kaushik S. Brainstem Evoked Response Audiometry (BERA) in Neonates with Hyperbilirubinemia. *Indian J Otolaryngol Head Neck Surg*. 2016;68(3):334-8.
15. Gurkov R, Eshetu T, Barreto Miranda I, Berens-Riha N, Mamo Y, Girma T, et al. Ototoxicity of artemether/lumefantrine in the treatment of falciparum malaria: a randomized trial. *Malar J*. 2008;7(1):179.
16. Weich TM, Tochetto TM, Seligman L. Brain stem evoked response audiometry of former drug users. *Braz J Otorhinolaryngol*. 2012;78(5):90-6.
17. Garg S, Sharma R, Mittal S, Thapar S. Alterations in brain-stem auditory evoked potentials among drug addicts. A cross-sectional study. *Neurosci. (Riyadh)*. 2015;20(3):253-8.

Cite this article as: Singh M, Minhas RS, Machhan P, Azad RK, Mohindroo S. Audiological assessment in organophosphorous poisoning. *Int J Otorhinolaryngol Head Neck Surg* 2018;4:966-9.