Audiological Assessment in Organophosphorus Compound Poisoning

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Abstract The aim of this prospective study design is to understand the audiological parameters in central and peripheral auditory pathway in organophosphorus compound (OPC) poisoning, within the setting of Tertiary care/ Medical College Hospital we studied Distortion Product Oto Acoustic Emission (DPOAE) and brain evoked response audiometry (BERA) in 25 patients with OPC poisoning with respiratory failure and 75 patients without respiratory failure. The results showed that DPOAE was absent in 17 patients with respiratory failure and 51 patients without respiratory failure. BERA showed significant prolongation in wave I, wave III and wave V latencies in both the groups. In conclusion, the current study has demonstrated significant changes in the auditory pathway both in peripheral and central with OPC exposure. The damage induced by these agents has been suggested as a combination of oto- and neurotoxicity with or without respiratory failure. Otolaryngologist should be alert to the toxic properties of OPC and conduct a comprehensive audiological assessment even in the conditions of deliberate poisoning.

Keywords Organophosphorus compound · Distortion product otoacoustic emission · Brainstem evoked response audiometry · Ototoxicity and neurotoxicity · Sensorineural hearing loss

Introduction

Organophosphorus compound (OPC) poisoning is a grave problem among rural population handling these compounds either by farmers or traders of insecticides. It is an occupational hazard. Especially among farmers it is a social problem. Psychiatric illness and deliberate OPC poisoning has received considerable attention [1]. There has been very few or no studies regarding audiological assessment in patients with OPC poisoning. The present study is a prospective analysis of the auditory functions in patients diagnosed with OPC poisoning.

Aim

The aim is to study the effect of OPC poisoning on the auditory pathway.

Material and Methods

It is a prospective observational study. The study group included 100 patients of OPC poisoning, out of which, 25 cases of OPC poisoning had respiratory failure and the remaining 75 patients were without respiratory failure. The patients were referred from the Department of Medicine after treatment and were later worked up in the Department of Otolaryngology. They were grouped in two groups viz study group and control group.

The *study group* is as follows:

Inclusion criteria	Age <45 years.
Exclusion criteria	H/o hearing loss, previous causes of middle or inner ear disease, chronic medical illness.

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The *control group* consisted of age and gender matched normal healthy subjects.

A detailed medical and otological history and physical, otolaryngological and neuro otological examination was done in all patients.

Each of these cases was then subjected to puretone audiometry, Distortion Product Oto Acoustic Emission (DPOAE) and brain evoked response audiometry (BERA).

Pure tone audiometry was done using MAICO MA 53 audiometer with TDH 39 head phones.

Impedance audiometry was done using MADSEN ZODIAC instrument and DPOAE and BERA were measured using HIS software with a single channel smart USB lite hardware.

Once it was ensured that suitable subjects were selected for the study, the subjects were evaluated by *DPOAE* testing.

DP-gram stimulus protocol include a frequency range from about 0.5–8 kHz with respect to geometric mean frequency, or 0.55–8 kHz re f_2 , along with a f_2/f_1 ratio of 1.22, a level difference of 10 dB, and absolute levels of $L_1 = 65$ dB SPL and $L_2 = 55$ dB SPL. The responses were considered as 'pass' if 7 out of 9 frequencies were above 6 dB noise level.

Brain Evoked Response Audiometry

Software: HIS, hardware: Smart USB lite single channel.

Using air conducted clicks as stimulus through ER3 insert ear phones at a rate of 19.3 sec.

Testing at 80 db nHL, Absolute and interpeak latencies of I, III, V and I–III, III–V and I–V were considered, respectively.

Results

Among 25 patients with OPC poisoning with respiratory failure, 11 (eleven) patients were male and 14 (fourteen) patients were female.

The age wise distribution is as follows:

Age (years)	No. of patients
15–20	04
21–25	10
26–30	04
31–35	04
36–40	03

The days spent on ventilator is as follows;

On ventilator (days)	No. of patients
<5	15
6–10	07
11–15	03

Table 1 BERA showing prolonged interpeak latency with respiratory failure

Interpeak latency	Right ear	Left ear	Total
I–III > 2.2 ms	5	3	8
III–V > 2.2 ms	4	8	12
I–V > 4.4 ms	4	6	10
Total	13	17	30

Table 2 BERA showing prolonged absolute latency with respiratory failure

Prolonged absolute latency	Right	Left	Total
Wave-I	9	8	17
Wave-II	7	7	14
Wave-V	8	9	17
Total	24	24	48

DPOAE: in 17 cases it was absent bilaterally and in 2 (two) cases unilaterally. In 6 (six) cases it was present bilaterally.

BERA: showing abnormality (Tables 1, 2).

In 25 patients having ventilatory support, 16 % of the ears had prolonged interpeak latency between I and III wave, 24 % of the ears had prolonged interpeak latency between III and V wave and 20 % of the ears had prolonged interpeak latency between I and V wave.

56 % of the patients had prolonged interpeak latency in the right ear and 68 % had prolonged interpeak latency in the left ear. Not even a single patient had single lesion. All the 25 patients on ventilator had multiple prolonged interpeak latencies in various segments. 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.

98 % of the patients had prolonged absolute latency in the right ear and same percentage of the patients had prolonged absolute latencies in the left ear in either wave-I, III or V. In non ventilatory cases (without respiratory failure):

(a) Sex distribution

Male	48 patients
Female	27 patients

(b) Age distribution

15–20 years	14 patients
21–25 years	17 patients
26–30 years	30 patients
31–35 years	6 patients
36–40 years	8 patients

In patients (75) without respiratory failure in OPC poisoning, DPOAE was absent in 44 patients bilaterally, seven

Table 3 BERA showing prolonged interpeak latency in patients without respiratory failure

Prolonged interpeak latency	Right	Left	Total
I–III > 2.2 ms	11	22	33
III–V > 2.2 ms	4	9	13
I–V > 4.4 ms.	3	3	6
Total	18	34	52

Table 4 BERA showing prolonged absolute latency without respiratory failure

Prolonged absolute latency	Right	Left	Total
Wave-I	19	13	32
Wave-II	26	30	56
Wave-V	28	30	58
Total	73	73	146

patients unilaterally and it was present in 24 patients (Tables 3, 4).

22 % of the ears had prolonged interpeak latency in wave I–III, 8.6 % of the ears had prolonged interpeak latency in wave III–V, 4 % of the ears had prolonged interpeak latency in wave I–V.

24 % of the patients had prolonged interpeak latencies in right ear and 45.33 % of the patients had prolonged interpeak latencies in the left ear in various segments.

Absolute latency was prolonged in 21.33 % of the ears in wave-I. 37.33 % of the ears showed prolonged absolute latency in wave-III and 38.66 % of the ears showed prolonged absolute latency in wave-V.

97.33 % of the patients had prolonged absolute latency in right ear and same percentage of the patients had prolonged absolute latency in the left ear in either wave I, III or V.

Discussion

Uses of organophosphorus compounds (OPC) ranges from agriculture to warfield [2]. The mechanism of toxicity of OP compounds is the inhibition of acetylcholinesterase (AChE), resulting in an accumulation of acetylcholine and the continued stimulation of acetylcholine receptors. Therefore, they are called anticholinesterase agents.

Their toxicities has been received equal importance and based on these properties the chemical warfare agents are developed [3]. In the last 50 years different OPC has been synthesized and marketed [4, 5]. Presently, more than 100 different OPC are used worldwide as insecticides [6]. The easy availability and innumerable benefits results in quite a number of intoxications [1, 6–10]. Use of pesticides is poorly

regulated and often dangerous; their easy availability also makes them a common mode of self poisoning [1, 8, 11].

The toxic manifestations and lethality after nerve agent exposure appear to follow the irreversible phosphorylation of the serine containing active site of AChE.

In respiratory failure there is a need to restore adequate arterial oxygen level for which oxygen therapy is important. The consequences of respiratory failure is systemic hypotension, pulmonary hypertension, polycythaemia, tachycardia and cerebral dysfunction ranging from confusion and coma [12–14].

The Oto- and neuro toxicity of OPC poisoning is something to be concerned of. The early literature was reviewed by Werner (1940), he had clearly described the ototoxic effects of variety of agents including arsenicals [15], ethyl and methyl alcohol, nicotine, bacterial toxins, and heavy metal compounds.

Oto toxic hearing impairment is exclusively sensorineural. Bilateral high frequency loss is the usual finding which corresponds to hair cell loss in the basal turn of the cochlea. Unilateral Cochlear and vestibular dysfunction is not uncommon [16]. The rapidity of onset and degree of hearing loss is usually dose-related and dependent on renal function. The loss is typically permanent.

Ototoxic substances acting on the vestibulocochlear system may damage the outer hair cells (OHC), the eighth cranial nerve, the vestibular system (CNS) [17]. There is evidence that hearing loss may be early manifestation of organophosphorus poisoning [18].

Several authors have described cases of sensorineural hearing loss due to exposure to agro chemical substances, ranging from mild to moderate loss. It has been reported that acute organophosphorus intoxication may cause profound bilateral hearing loss. The literature has reported that higher frequency auditory thresholds are more prone to damage [19].

Conclusion

The most life threatening complication is respiratory failure, which is mainly due to central effect of the nerve agents. Hypoxia is also a major problem in the OPC, which may cause cerebral edema and convulsion and induces histopathologic brain damage.

In our present study, we understand that exposure to OPC poisoning with or without respiratory failure has definitive detrimental effect on the auditory pathway.

Considering all these effects of OPC on the central nervous system and subtle effects on the peripheral and central auditory pathway, it is advisable to keep a tab on the patients during the recovery phase and on follow-up in the due course.

References

1. Eddleston M, Gunnell D, Karunaratne A, de Silva D, Sheriff MH, Buckley NA (2005) Epidemiology of intentional self-poisoning in rural Sri Lanka. *Br J Psychiatry* 187:583–584
2. Balali Mood M, Shariat M (1998) Treatment of organophosphate poisoning. Experience of nerve agents and acute pesticide poisoning on the effects of oximes. *J Physiol Paris* 92:375–378
3. Minton NA, Murray VS (1988) A review of organophosphate poisoning. *Med Toxicol Adverse Drug Exp* 3:350–375
4. Ballantyne B, Marrs T (1992) Overview of the biological and clinical aspects of organophosphates and carbamates. In: Ballantyne B, Marrs TC (eds) *Clinical and experimental toxicology of organophosphates and carbamates*. Butterworth and Heinemann, Oxford, pp 3–14
5. Eto M (1974) *Organophosphorus pesticides: organic and biological chemistry*. CRC Press, Cleveland
6. Kwong K (2002) Organophosphates pesticides: biochemistry and clinical toxicology. *Ther Drug Monit* 24:144–149
7. Forget G (1991) Pesticides and the Third World. *J Toxicol Environ Health* 32:11–31
8. Amr MM (1999) Pesticide monitoring and its health problems in Egypt, a Third World country. *Toxicol Lett* 107:1–13
9. Cocker J, Mason HJ, Garfitt SJ, Jones K (2002) Biological monitoring of exposure to organophosphates pesticides. *Toxicol Lett* 134:97–103
10. Brown MA, Brix KA (1998) Review of health consequences from high-, intermediate-, and low level exposure to organophosphorus nerve agents. *J Appl Toxicol* 18:393–408
11. Eddleston M, Karalliedde L, Buckley N, Fernando R, Hutchinson G, Ishiter G et al (2002) Pesticide poisoning in the developing world—a minimum pesticides list. *Lancet* 360:1163–1167
12. Thiermann H, Szinicz L, Eyer F, Worek F, Eyer P, Felgenhauer N et al (1999) Modern strategies in therapy of organophosphate poisoning. *Toxicol Lett* 107:233–239
13. Sidell FR (1974) Soman and Sarin: clinical manifestations and treatment of accidental poisoning by organophosphates. *Clin Toxicol (Phila)* 7:1–17
14. Rengstorff RH (1985) Accidental exposure to sarin: vision effects. *Arch Toxicol* 56:201–203
15. Bencko B (1977) Test of environmental exposure to arsenic and hearing changes in exposed children. *Environ Health Perspect* 19:95–101
16. Lim DJ (1986) Effects of noise and ototoxic drugs at the cellular level in the cochlea: a review. *Am J Otolaryngol* 7:73–99
17. Bernandi APA (2003) Testes utilizados na avaliacao de trabalhadores expostos a niveis de pressao sonora elevados e solventes. Em: Bernadi APA. *Conhecimentos essenciais para atuar bem em empresas: audiologia ocupacional*. Colecao CEFAC. Sao Jose dos campos: Pulso, pp 67–80
18. Manjabosco CAW, Morato TC, Marques SJM (2004) Perfil audiometrico de trabalhadores agricolas. *Arq int otorrinolaringol* 8(4):284–295
19. Harell M, Shea JJ, Ernett JT (1987) Bilateral sudden deafness following combined insecticide poisoning. *Laryngoscope* 88: 1348–1351