National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Nerve conduction studies in cases with long-term unintentional exposure to pesticide spraying

Sakshi Gawande[1], Shivaji Chalak[2], Ashish Banginwar[3], Kiran Avachar[2], Jagdish Powar[3], Prafulla Chandak[2]

[1]Final Year MBBS Student, SMBT Institute of Medical Sciences and Research Centre, Dhamangaon, Igatpuri, Nashik, Maharashtra, India, [2]Department of Physiology, SMBT Institute of Medical Sciences and Research Centre, Dhamangaon, Igatpuri, Nashik, Maharashtra, India, [3]Department of Community Medicine, SMBT Institute of Medical Sciences and Research Centre, Dhamangaon, Igatpuri, Nashik, Maharashtra, India

Correspondence to: Shivaji Suryabhan Chalak, E-mail: shivajichalak@rediffmail.com

Received: August 03, 2017; **Accepted**: August 18, 2017

ABSTRACT

Background: Farm workers experience many work-related hazards, including exposure to organophosphorus (OP) compounds during the process of pesticide spraying during their crop season. The recurrent unintentional exposure to OP compounds may lead to motor and sensory nerve neuropathies and also have some delayed neurological sequels. **Aims and Objectives:** The aims of this study were (1) to find out the toxic effects of OP compound on motor nerve conduction velocity (MNCV) and (2) to compare the MNCV, in selected peripheral nerve (median nerve) of affected population with the normal population. **Materials and Methods:** A cross-sectional analytical study was conducted by recruiting 60 individuals matched with height, weight, and occupation matched (control group 30 and study group 30). Participants were selected randomly from the outpatient Department of Medical College Hospital with age group between 20 and 40 years, and both sexes were included. The MNCVs were recorded using multichannel polyrite machine. **Results:** MNCVs were evaluated on median nerves of both the sides. MNCV was recorded on distal stimulation. Our findings show that the motor abnormalities nerve velocities in case of exposed population were significantly less as compared to the controls in tested median nerve. This indicates the presence of abnormalities such as neuropathy in these patients. **Conclusion:** There was an evidence of peripheral neuropathy to some extent in peripheral nerves as evident by slow MNCVs in median nerve of those farmers who were exposed to the OP pesticide spraying in the farms and its consequent absorption through skin, inhalation, or ingestion as compared to the normal individuals.

KEY WORDS: Organophosphorus; Motor Nerve Conduction Velocity; Median Nerve; Acetylcholine; Peripheral Neuropathy

INTRODUCTION

Farming is the major occupation in Indian rural population, and the farmers are recurrently exposed to organophosphorus (OP) chemical compounds during pesticide spraying. A pesticide intoxication usually occurs when chemicals intended to control the pests and disease are sprayed on the crop for the sake of good quality yield.[1] The unprotected handling of such poisonous chemical compounds during spraying seasons leads to frequent exposure of farmers to such toxic agents.[2,3] As a consequence, they are intoxicated by accidental absorption of such compounds through the skin (transdermal), mucosa, inhalation, or ingestion following acute or chronic, short- or long-term exposure, for more than one occasion.[4]

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2018.8.0831918082017	

Farm workers are exposed to many work-related health problems, and most of them are unintentional exposure to OP pesticides. Long-term effects with pesticides spraying are a global public health problem that accounts for as many as 300,000 deaths worldwide every year. The majority of deaths occur due to exposure to organophosphates, organochlorines, and aluminum phosphides.[5] OP pesticides are the most commonly available over-the-counter insecticides in India for agricultural and household use, and easy availability of such chemical components makes the farmers more vulnerable to its adverse effects.[6,7]

Pesticide spraying-induced delayed neuropathy is a most of the times a symmetrical sensory-motor neuropathy, which is seen to affect most severely in long axons and occurring some weeks after exposure. In other study, no or mild changes which are in association with cholinergic overstimulation were reported in the patients.[8]

Pesticide spraying process is associated with increased risk of neurotoxic effects on peripheral nerves, and the severity of poisoning depends on the dose and the type of organophosphate exposure. Chronic low-level exposure in non-poisoned subjects has been associated with impaired neurological functions, as documented in some epidemiological studies. In some animal studies, axonal degeneration and demyelination following acute OP poisoning are observed.[9] In another study, neuropsychological dysfunction with a single episode of acute unintentional OP intoxication has also been reported. It has been observed that human nerve conduction studies (NCSs) in farm workers who had chronic and low-level exposure to pesticides have shown motor neuropathies. It is characterized by distal degeneration of some axons of both the peripheral and central nervous systems occurring 1-4 weeks after single or short-term exposures. Effects of chronic mixed pesticide exposure on autonomic nerve function were also demonstrated by Jayasinghe et al. in 2012.[10]

OP compounds belong to the group of anticholinesterase agents and are potent inhibitors of acetylcholine (ACh) hydrolysis. The accumulation of Ach, therefore, results in stimulation of nicotinic and muscarinic receptors, and hence, cause cholinergic toxicity. In few others, they are known to produce a very specific syndrome of delayed peripheral neuropathy.

The nerve conduction velocity study (NCVS) is a electrophysiological test that can be used to assess the conduction of electrical impulses down to peripheral nerves. Various anomalies in the nerve conduction could be analyzed using the principle that the nerves transmit the action potentials at a standard velocity and peaks and such nerve anomalies can alter that these impulses can be detected by NCVS. The tests are helpful in detecting the abnormal functioning of peripheral nerves and likely disorder.[11]

Need for Study

The catchment area of the Medical College Hospital has a tribal population with farming as their means of livelihood, and the majority of the farmers are abundantly using pesticides spray for cultivation. Moreover, access to these poisonous chemical substances is easy for such individuals. The chemicals may be inhaled, ingested, or it may get spilled on the skin accidentally during spraying. The issue is becoming serious and has a disastrous adverse effect on the health of such population. Hence, this study is being conducted to find out the effect of OP pesticides spraying on peripheral nerves among the rural population of Nasik district.

The objectives of the present study were to study the electrophysiological effects following recurrent exposure to low-dose OP pesticides, by recording motor nerve conduction velocity (MNCV) in rural population.

MATERIALS AND METHODS

Place of Work

The present study was carried out in the Department of Physiology, SMBT Institute of Medical Sciences and Research Centre, and 700-bedded tertiary hospital which is situated in a hilly and tribal area. Approval for the study was obtained from the Institutional Ethical Committee, vide letter SMBT/Institutional Ethics Committee /06/112 dated March 22, 2016.

Study Design

It is a cross-sectional analytic study.

Selection of Sample

The sample size included 60 individuals, which were divided into control and study groups. The study group included 30 individuals who had a history of unintentional exposure to pesticide spraying, and the control group included 30 height-, weight-, and occupation-matched normal individuals with no history of exposure. Most of the patients selected were from the age group of 20 to 40 years, and both males and females were included. The selected subjects were the farmers, with the history of day-to-day unintentional exposure to pesticide spraying. The participants of the study group were selected on the basis of detailed history, duration of exposure to pesticide for more than 15 days during the past 2 years. The participants were selected from the general hospital outpatient department (OPD) and during field visits, conducted by the Department of Community Medicine. Those selected during field visits were later called to the OPD for necessary investigations. The control group population was selected among the healthy people and relatives visiting the OPD.

Instrumentation and Laboratory Method

After taking detail history of the subjects regarding exposure to OP pesticide spraying, informed consent was obtained. The procedure for NCS test was explained to the subjects. The MNCVs were recorded with the help of computerized multichannel polyrite machine using conducting jelly and the recording electrodes. The stimulus was given with the help of surface stimulating electrodes using supra-maximum stimulus.[12] MNCVs were recorded in median nerve of upper extremity on both right and left sides.[10]

Inclusion Criteria

1. Farmers who were exposed day-to-day to the OP pesticides spraying with the duration of exposure to pesticide for more than 15 days, within the past 2 years, were enrolled as cases
2. Normal healthy individuals with the age group of 20-40 years were included for comparison.

Exclusion Criteria

1. Subjects with any pre-existing neurological disorders and with history of tobacco consumption
2. Subjects with any other systemic diseases such as diabetic neuropathy, carpel tunnel syndrome, and Guillain-barre syndrome were excluded from the study.

Statistical Analysis

Statistical analysis was done by descriptive and inferential statistics using student's paired *t*-test, using software statistical package for the social sciences 17.0 version. $P < 0.05$ was considered as statistically significant.

RESULTS

In all, 60 farmers were included in the study among which 30 farmers were those who were unintentionally exposed day-to-day to the OP pesticides spraying with the duration of exposure to pesticide for more than 15 days. In all, 30 normal healthy subjects with age group of 20-40 years were included for comparison. Table 1 shows the type of OP pesticide to which the study group patients were exposed. Table 2 shows the mean descriptive data of demographic and anthropometric parameters of the participants. Table 3 shows a comparison of mean values of left-sided median nerve MNCV of the control and study group. The MNCV in the study group was significantly less as compared to the control group (*P* value is considered statistically significant at < 0.05). Table 4 shows a comparison of mean values of right-sided median nerve MNCV of the control and study group. The MNCV in the study group was significantly less as compared to the control group (*P* value is considered statistically significant at < 0.05). Table 5 shows a comparison of mean values of average left- and right-sided median nerve MNCV of control and study group. The values show that in study group the MNCV is significantly less as compared to the controls (*P* value being < 0.05 considered as statistically significant).

Table 1: Type of OP pesticide to which the study group patients were exposed

Type of OP	Number of cases exposed to OP
Malathion	10
Fenthion	8
Dimethoate	2
Unknown pesticide	10

OP: Organophosphorus

Table 2: Mean descriptive data of demographic and anthropometric parameters of the participants

Descriptive data	Patients	Controls
Age (years)	32	24
Gender (males/females)	30/0	27/3
Height (cm)	174	175
Weight (kg)	59	62

DISCUSSION

A cross-sectional analytic study was conducted in an age group between 20 and 40 years, and both the sexes were included. The selected subjects from the above said age group were the farmers who were unintentionally exposed to day-to-day OP pesticides spraying.

Two group were formed as follows:

- Group 1 (control group): Normal healthy age and gender-matched subjects those who were accompanying the patients with age group 20-40 years ($n = 30$)
- Group 2 (study group): Farmers who were exposed day-to-day to the OP pesticides spraying with duration of exposure to pesticide for more than 15 days, within the past 2 years ($n = 30$).

MNCV on median nerves on both sides was recorded and analyzed. Our findings show that the motor nerve velocities in case of exposed population were significantly less as compared to the controls in tested median nerve which indicates the abnormalities such as neuropathy in such patients. These findings suggest that there were focal lesions in these nerves leading to neuropathy, and hence, reducing the nerve conduction velocities in median nerves.

Peripheral neuropathy is caused by diffuse lesions of peripheral nerves and is clinically manifested by weakness,

Table 3: Comparison of mean values of left-sided median nerve MNCV of control and study group

Number of participants/ group	Method of evaluation	NCV (mean±SD) in m/s	Normal NCV values in m/s	SEM
30 controls	Left-sided median nerve conduction velocities	56.3±2.4	56.7±3.8	0.4
30 study group	Left-sided median nerve conduction velocities	43.6±4.9	56.7±3.8	0.9

P=0.035 (*P*<0.05 is considered as statistically significant). MNCV: Motor nerve conduction velocity, SEM: Standard error of the mean, SD: Standard deviation, NCV: Nerve conduction velocity

Table 4: Comparison of mean values of right-sided median nerve MNCV of control and study group

Number of participants/ group	Method of evaluation	NCV (mean±SD) in m/s	Normal values in m/s	SEM
30 controls	Right-sided median nerve conduction velocities	57.2±2.8	56.7±3.8	0.5
30 study group	Right-sided median nerve conduction velocities	44.4±5.6	56.7±3.8	1.0

P=0.041 (*P*<0.05 is considered as statistically significant). SEM: Standard error of the mean, SD: Standard deviation, MNCV: Motor nerve conduction velocity, NCV: Nerve conduction velocity

Table 5: Comparison of mean values of average left- and right-sided median nerve MNCV of control and study group

Number of participants/ group	Method of evaluation	NCV (mean±SD) in m/s	Normal values in m/s	SEM
30 control	Average (right and left) median nerve conduction velocities	56.8±2.5	56.7±3.8	0.4
30 study	Average (right and left) median nerve conduction velocities	44.02±5.2	56.7±3.8	0.9

P=0.015 (*P*<0.05 is considered as statistically significant). SEM: Standard error of the mean, SD: Standard deviation, MNCV: Motor nerve conduction velocity

sensory loss, and impairment of reflexes. The diagnosis is based on the clinical presentation and which is further confirmed by electrophysiological diagnostic techniques such as NCSs.[13]

Our study revealed clinical signs of mild changes of peripheral neuropathy after exposure to OP pesticides spraying, in farmers. The electrophysiological changes in our study showed median motor nerve involvement after being exposed to long-term low-dose of OP pesticides. Our findings are compatible with the reports of Misra et al.[14] and Jalali et al.,[1] in which they demonstrated that the patients exposed to OP pesticides had significantly low nerve conduction velocities suggestive of peripheral neuropathy.

Moretto and Lotti[15] conducted a study and searched for sensory and motor components of neuropathy in which they found more motor involvement as compared to sensory component. They also explained that motor neuropathy occurs after moderate-to-severe OP toxicity.

Ergün et al. studied that the routes of OP pesticide entry into the body are mainly absorption through skin, inhalation, and oral ingestion either accidently or unintentionally which can lead to long-term effects such as peripheral neuropathy. Acute OP poisoning usually occurs after intentional oral intake as in case of suicidal attempt, whereas chronic exposure usually follows inhalation or subdermal absorption through the skin.[16]

In an another study by Nand et al.,[4] the electrophysiological examination revealed markedly reduced amplitude of the compound muscle action potential (CMAP) with reduced MNCV in the tibial nerve of both lower limbs. CMAP and MNCV were not recordable in the peroneal nerve of both lower limbs and mildly reduced in median and ulnar nerve.

The present study was performed in farmers belonging to area around our workplace who were exposed to OP pesticide spraying in their farms. Such patients were included in the study on the basis of the history of exposure and consequent absorption of such OP pesticides. Clinical presentation of acute OP poisoning usually presents with cholinergic crises, central nervous system depression, and more often intermediate syndrome consisting of skeletal muscle weakness and paralysis.

The findings of our study show that the median MNCVs in case of exposed population were significantly less as compared to the controls in tested median nerves, indicative of nerve abnormalities such as peripheral neuropathies in such patients, due to its late effects. The mean values of left- and right-sided nerve conduction velocities of median nerve were significantly reduced as compared to controls in our study. The mean values of average nerve conduction velocities of the left and right side median nerve were also compared, and it was found that the mean average values were significantly less as compared to the control group.

These findings suggest that there were focal lesions in these nerves leading to neuropathy, and hence, reducing the nerve conduction velocities in median nerves. Diabetes mellitus can also produce the similar findings in NCSs, and hence, we had excluded such patients from our study.

Implication of the Study

Poisoning due to chronic exposure to pesticide spraying is now becoming a global public health problem. People suffer from irreversible long-term effects of OP pesticide exposure leading to peripheral nerve disorders such as peripheral neuropathies.

This pilot study can be a benchmark for further evaluation of such disorders. Moreover, further similar elaborative studies can be undertaken by selecting larger sample size for more confirmatory results and evaluating various other nerve involvement with added sensory components to find out the effect of above risk factors on peripheral nerves. The results of this study can be utilized for planning of preventive and control measures.

CONCLUSION

Our study concluded that there was an evidence of peripheral neuropathy to some extent in peripheral nerves as evident by slow MNCVs in median nerve of those farmers who were exposed to the OP pesticide spraying in the farms and its consequent absorption through skin, inhalation, or ingestion as compared to the normal individuals.

REFERENCES

1. Jalali N, Balali-Mood M, Jalali I, Shakeri MT. Electrophysiological changes in patients with acute organophosphorous pesticide poisoning. Basic Clin Pharmacol Toxicol. 2011;108(4):251-5.
2. Steenland K, Jenkins B, Ames RG, O'Malley M, Chrislip D, Russo J. Chronic neurological sequelae to organophosphate pesticide poisoning. Am J Public Health. 1994;84(5):731-6.
3. Goel A, Aggarwal P. Pesticide poisoning. Natl Med J India. 2007;20(4):182-91.
4. Nand N, Aggarwal HK, Bharti K, Chakrabarti D. Organophosphate induced delayed neuropathy. J Assoc Phys India. 2007;55:72-3.
5. Erdman AR. Insecticides. In: Dart RC, editor. Medical Toxicology. 3rd ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2004. p. 1475-96.
6. Eddleston M, Phillips MR. Self poisoning with pesticides. BMJ. 2004;328(7430):42-4.
7. Jeyaratnam J. Acute pesticide poisoning: A major global health problem. World Health Stat Q. 1990;43(3):139-44.
8. Kaplan JG, Kessler J, Rosenberg N, Pack D, Schaumburg HH. Sensory neuropathy associated with Dursban (chlorpyrifos) exposure. Neurology. 1993;43(11):2193-6.
9. Pathak MK, Fareed M, Srivastava AK, Pangtey BS, Bihari V, Kuddus M, et al. Seasonal variations in cholinesterase activity, nerve conduction velocity and lung function among sprayers exposed to mixture of pesticides. Environ Sci Pollut Res Int. 2013;20(10):7296-300.
10. Jayasinghe SS, Pathirana KD, Buckley NA. Effects of acute organophosphorus poisoning on function of peripheral nerves: A cohort study. Public Librar Sci. 2012;7(11):e49405.
11. Agarwal P, Gaur AK. Effect of obesity on median nerve conduction at carpal tunnel level in Indian women. Natl J Physiol Pharm Pharmacol. 2015;5(1):21-4.
12. Yogita DS, Rahul PB. Impact of height on sensory nerve conduction. Natl J Physiol Pharm Pharmacol. 2017;7(8):851-4.
13. Joshi VS. Nerve muscle physiology changes with yoga in professional computer users. Natl J Physiol Pharm Pharmacol. 2017;7(8):815-9.
14. Misra UK, Nag D, Khan WA, Ray PK. A study of nerve conduction velocity, late responses and neuromuscular synapse functions in organophosphate workers in India. Arch Toxicol. 1988;61(6):496-500.
15. Moretto A, Lotti M. Poisoning by organophosphorus insecticides and sensory neuropathy. J Neurol Neurosurg Psychiatry. 1998;64(4):463-8.
16. Ergün SS, Oztürk K, Su O, Gürsoy EB, Ugurad I, Yüksel G. Delayed neuropathy due to organophosphate insecticide injection in an attempt to commit suicide. Hand (N Y). 2009;4(1):84-7.

How to cite this article: Gawande S, Chalak S, Banginwar A, Avachar K, Powar J, Chandak P. Nerve conduction studies in cases with long-term unintentional exposure to pesticide spraying. Natl J Physiol Pharm Pharmacol 2018;8(2):182-186.

Source of Support: Nil, **Conflict of Interest:** None declared.