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Original Research Article

A PROSPECTIVE STUDY OF PSEUDO CHOLINESTERASE IN ORGANOPHOSPHORUS POISONING

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ABSTRACT

In many developing countries like India poisoning due to organophosphorous (OP) is a most common public health problem. Organic insecticides and pesticides are frequently used in agricultural segment. Of these organo insecticides are abused for suicidal purpose in rural areas of the country. Easy approachability, low cost and because of its quick action, rural population select this method. OP acts by inhibiting the enzyme cholinesterase, resulting in accumulation of acetylcholine at synapses and myoneural junction leading to cholinergic over activity. Depressed serum butyrylcholinesterase or red blood cells cholinesterase level suggests the diagnostic marker and severity of acute OP poisoning. Estimate the level of pseudocholinesterase as a diagnostic and prognostic marker of organophosphorus poisoning. The study is a hospital based study for one and half year from June 2013 to December 2014. It was conducted in a medical emergency ward of tertiary care hospital located at MGM Hospital Kakatiya Medical College. 122 study subjects were patients getting admitted. with OP poisoning in the age group in between 19 to 50 were included meeting the inclusion criteria to recruit in the study. Patients below 19 years, chronic hepatic disease sufferers and pregnant were excluded for the study. The results were analyzed by using SPSS software. The patients categorized in to four levels as per Pseudocholinesterase levels. 5 ml of venous blood collected in plain tubes and subjected to 3000 rpm for 10 minutes. Separated serum 2 hours after collection of blood. Serum Pseudocholinesterase level was estimated initially before treatment on day 1 and after 48hrs of treatment. Enzyme levels were estimated by adopting New German Society for Clinical Chemistry (DGKC) procedures. Above the 50% of included subjects are in the age group of 19-30 years and of these predominant are the male subjects over females. The mean values of cholinesterase were found to be low in cases as compared with controls. OP poisoning is diagnosed by history of symptoms and signs and by estimation of pseudo cholinesterase (PChE) enzyme which is present in serum and is closely resembles RBC acetyl cholinesterase present at the nerve endings which is responsible for the breakdown of acetylcholine.

Keywords: Organophosphorous poisoning, Cholinesterase, Pseudo cholinesterase.

INTRODUCTION

Organophosphorus (OP) pesticide poisoning is major public health problem in many developing countries. They are insecticides of choice in the agricultural world and are the most common cause of poisoning among organic insecticides.1 Apart from use of these substances as agricultural insecticides, they are frequently abused for suicidal purposes particularly in rural areas because of their low cost, rapid action and easy availability. Organophosphorus pesticides (OP) are esters of phosphoric or thiophosphoric acids and are highly toxic to mammals because of their capacity to phosphorylate the active site of acetyl

cholinesterase (AChE), leading to accumulation of acetylcholine in synapses.[2] OP acts by inhibiting the enzyme cholinesterase, results in accumulation of acetylcholine at synapses and myoneural junction leading to cholinergic over activity.[3] Organophosphate (OP) compounds are a diverse group of chemicals used in both domestic and industrial settings. Examples of organophosphates include insecticides like malathion, parathion, diazinon, fenthion, dichlorvos, chlorpyrifos, ethion, nerve gases like soman, sarin, tabun, VX, ophthalmic agents like echothiophate, isoflurophate, and antihelmintics like trichlorfon. Herbicides like tribufos (DEF), merphos are tricresyl phosphate–containing industrial chemicals.[4] Some highly potent OP anticholinesterase compounds including tabun, soman and VX have been used as "nerve gases" in chemical warfare.[5] India being an agricultural country we can find an extensive use of Organophosphate compounds making them accessible for the reach of common man. Based on extrapolations from limited data, it was estimated that 3 million cases of pesticide poisonings occurred.[6] According to estimates of World Health Organization (WHO) nearly 200000 people die from pesticide poisoning in each Year.[7] Inphosphorylation and loss of AchE activity thus may cause a range of effects resulting from excessive nervous system stimulation and culminating in respiratory failure and death. 8 The diagnosis and severity of acute OP poisoning is suggested by a depressed serum butyrylcholinesterase or red blood cells cholinesterase level.[9]

MATERIALS AND METHODS

Source data

The study was conducted in MGM Hospital Kakatiya Medical College for a period of one and half year i.e., June 2013 to December 2014. 122 patients of registered organophosphorus poisoning were admitted to medical emergency ward (Acute Medical Care) MGM Hospital, in have formed the material for study.

Study design: Hospital based prospective study.

Inclusion Criteria

- In this study patients above 19 years with registered Organophosphorous compound poisoning were included.

Exclusion Criteria

- Patients below 19 years
- Those who have consumed other drugs along with OPC
- Patients with prior hepatic dysfunction and chronic conditions which may reduce the levels of Butyryl cholinesterase levels are also excluded.
- Pregnancy

Control Inclusion Criteria

122 subjects with age above 19 years who were not suffering from any medical or surgical illness were included in the study. All the cases and controls satisfying inclusion and exclusion criteria were included.

Sample Collection

5ml of venous blood was collected from all the study participants under aseptic conditions in a plain tube. Sample was centrifuged at 3000 r.p.m for 10 minutes and serum was separated within two hours of collection of blood. Care was taken to prevent hemolysis of the samples. Lipaemic and icteric samples were discarded.

The following parameter were estimated in both the groups:

Serum Pseudo cholinesterase level initially before treatment on day 1 and 48 hrs after treatment.

Estimation Procedures for Analyte:

1. Serum Cholinesterase Estimation

Method: New German Society for Clinical Chemistry (DGKC) method.

RESULTS

In the present study, the majority of the study population is in the age group of 19-30 years which is 63.93%. followed by 31-40 years 26.25% and 9.83% of 41-50 years respectively (Table 1). Out of 122 cases (80) 65.57%were males and (42) 34.42% were females, indicating male predominance (Table 2). The mean value of pseudo cholinesterase on day1 (the admission day) is lower (2719.40 U/L) in Cases when compared to controls (5086.90 U/L) and it is statistically significant with p value 0.001 (Table 3). The mean value of pseudo cholinesterase after 48 hrs of treatment is higher (4499.53 U/L) when compared to on day 1(2719.40 U/L) of the admission and it is statistically significant shown p value 0.001 (Table 4).

Table 1: Age Wise Distribution of Cases

Age in years	No. of cases	Percentage
19-30	78	63.93%
31-40	32	26.25%
41-50	12	9.83%
Total	122	100%

Table 2: Gender Wise Distribution of Cases

Gender	NO. of cases	Percentage
Male	80	65.57%
Female	42	34.42%
Total	122	100%

Table 3: Serum PChE in OP Poisoning Patients and Controls (On Day1of the Admission)

Parameter	Groups	Minimum	Maximum	Mean	Std. Deviation	P value
PChE on day 1 of admission(U/L)	Cases(122)	2015	3812	2719.40	591.831	0.001
	Controls(122)	3676	6549	5086.90	818.601	

Table 4: Serum PChE in OP Poisoning Patients On Day1and 48 Hrs After Treatment

Parameter	Groups	Minimum	Maximum	Mean	Std. Deviation	P value
PChE(U/L)	Day1(N=122)	2015	4218	2719.40	581.881	0.001
	After48hrs of treatment(N=122)	4026	5696	4499.53	351.065	

DISCUSSION

OP compound poisoning is important indication for emergency admission in most hospitals throughout India. OP compounds are used as pesticides, herbicides, chemical warfare agents in form of nerve gases. Its widespread use and easy availability has increased the likelihood of poisoning with these compounds.

WHO estimates that approximately 3 million pesticide poisoning occur worldwide and cause more than 2,20,000 deaths. Developing countries like India and Srilanka report alarming rates of toxicity and death.[10] Exposure to organophosphates in an attempt to commit suicide is a key problem, particularly in the developing countries (rural areas mainly), and is a more common cause of poisoning than the chronic exposure experienced by farmers or sprayers in contact with pesticides like monocrotophos, quinolphos, cyanofephos, chloropyrofos, malathion etc. Organophosphorus compounds are acid-transferring inhibitors of cholinesterase. OP acts by inhibiting the enzyme cholinesterase, results in accumulation of acetylcholine at synapses and myoneural junction leading to cholinergic over activity.[11] Acetyl cholinesterase is present in two forms: True acetyl cholinesterase which is found primarily in the tissues and erythrocytes, and pseudo cholinesterase which is found in the serum and liver. OPC cause cholinesterase to become firmly (and sometimes irreversibly) phosphorylated. This means that the action of cholinesterase will be inhibited. Cleavage of the carbon-enzyme bond from ACh is complete in a few microseconds. However, the breaking of the phosphorus-enzyme bond requires a period varying from 60 minutes to several weeks, depending on the organophosphorus compound involved. In the study majority of the victims were males 60% when compared to female 40%, which is similar to previous studies by Karki P et al's,[12] Siwach SB et al's,[13] reported reasons for the suicide in males may include lack of employment, poverty, and various other stress related factors. In females, it may be due to marital disharmony. Our study correlated well with Sahin et al's study.[14]

In the study majority of the victims were in the age group of 19-30 years, it was 63.93%, which is similar to that in other studies Karki P et al's,[12] Sahin et al's study,[14] Paudyal BP. Et al's,[15] Dash et al's,[16] Siwach SB etal's,[13] This age group was the most active one, physically, mentally and socially and so it was more prone to stress during life.

Pseudo cholinesterase (PChE) also known as butyrylcholinesterase (BChE), or plasma/serum cholinesterase is a serine hydrolase capable of hydrolyzing esters including acetylcholine etc.[17]

Organophosphate compounds irreversibly inhibit the enzyme, acetyl cholinesterase. They combine with acetyl cholinesterase to form a phopshorylated enzyme (enzyme–OP complex); reactivation can be achieved by pharmacological agents such as oximesect. The action of oximes is limited by the aging reaction, a time- dependent process that hydrolyses the enzyme– OP complex. As a result of aging, the enzyme is not susceptible to reactivation by oximes. As a general rule, the aging reaction occurs 48–72 hours after poisoning.18 In the study pseudo cholinesterase levels in patients showed a statistically significant decreased in mean value (p value 0.001) when compared to healthy controls on the day of admission. So in our study OP poisoning is evaluated by assessing pseudo cholinesterase levels as a marker and is therefore useful in establishment of diagnosis and severity of poisoning. The mechanism involved is organophosphate inactivate ChE by phosphorylating the serine hydroxyl group located at the active site of ChE. In ROC curve analysis, Serum PChE has showed good diagnostic efficiency in discriminating day1 cases from controls. In a study conducted earlier by Arygun et al,[19] on patients with OP poison, acetylcholinesterase levels on admission were evaluated, and low levels of serum acetylcholinesterase were reported to support the diagnosis of acute OP poisoning and was explained as normally the acetylcholine attaches to esteric site of serum cholinesterase and cleaves into acetic acid and choline, but in organophosphorus poisoning the esteric site is phosphorylated by OPC ,so the enzyme serum cholinesterase is inhibited (decreased levels on assay) and cannot hydrolyze acetylcholine (increased at synapses) Aygun et al,[19] From the study in majority of patients it was observed that on admission the enzyme activity was low. Hence it can be inferred that low pseudo cholinesterase activity can be taken as good diagnostic marker for OP poisoning. Studies by Namba T et al and Wadia R.S et al have also shown that pseudo cholinesterase activity estimation is a reliable diagnostic test in OPC poisoning. Observations from this study have shown that

patients with higher pseudo cholinesterase activity on the day of admission had mild symptoms compare with those who had lower values (moderate and severe symptoms). Hence estimation of pseudo cholinesterase level is also useful to find out the severity of poisoning. In the study there was statistically significant (p value 0.001) PChE levels in patients after 48 hrs of treatment compared to 1st day of admission. The increased level of cholinesterase was due to reactivation by a strong nucleophile such as pralidoxime (2- PAM). This was studied by Wilson. Et. al,[20] came to the conclusion that when a radical having a positive electric charge and affinity for anionic site will reactivate a group from the phosphorylated cholinesterase or inhibited cholinesterase and restores the activity of the enzyme that means increased levels, Wilson. et. al. 20 Our present study well correlated with the previous studies substantiating the objective of the study.

CONCLUSION

From the results of the study, pseudocholinesterase shows to be a marker of diagnostic value in OP poisoning. Decreased activity of pseudocholinesterase was significantly correlating with registered cases of OP poisoning and it was also observed that the activity of pseudocholinesterase on day1 and after 48hrs of treatment correlated well with the severity of the symptoms. So decreased pseudocholinesterase activity can be useful as a diagnostic marker even in cases if poisoning where the offending agent is unknown and to assess severity of the condition. ROC curve analysis showed PChE is the best discriminatory marker in the diagnosis in patient's exposure to OP poisoning. From the study it can be concluded that pseudocholinesterase (PChE) is a diagnostic and prognostic marker useful in assessing the severity, so it can contribute to increase the success rate in the treatment and recovery of these patients.

REFERENCES

1. Eddleson M. Patterns and problems of deliberate self-poisoning in the developing world. QJM 2009; 93:71
2. Jan L De Bleeker, Jacques L De Reuck, Jan L Willems. Clinical Neurology and Neurosurgery, 1992, 94, 93-103
3. Guyton Arthur C: Textbook of Medical Physiology. 9th edn.
4. Boobis AR, Ossendrop BC, Banasiak U Hamey PY, Sebestyen I,Moretto A. Cumulative risk assessment of pesticide residues in food Txicol Lett.Aug 15 2008;180(2) :137-50. [Medline].
   Bouvier G,Vigouroux-Villard,Blanchard O, Momas I . Insectiside urinary metabolites in no occupationally exposed populations. J Toxical Environop Health B Crit Rev. Nov-Dec 2005; 8(6):485-512.[medline].
5. Bairy KL, Vidyasagar S, Sharma A, Sammad V. Controversies in the management of organophos phate poisoning. Ind J Pharmacol. 2007; 39(2):714.
6. World Health Organization in collaboration withthe United Nations Environmental Programme.
   Public impact of pesticides used in agriculture. Geneva: WHO, 1990.
7. Abdollahi, M.; Kebriaeezadeh, A.; Akkhgari, M.; et al.; (1995): "Cholinesterase levels in saliva, plasma and erythrocytes of Iranian population". Tox. Lett., 78:1-88.
8. Aaron CK. Organ phosphorous and carbamates. In: Shannon MW, Borron SW, Burns MJ(eds) Haddad and Winchester 's Clinical management of poisoning and drug overdose .4th ed Philadelphia: Sanunders Elsevier, 2007.
9. Darren M Roberts, Cynthia K Aaron. Managing acute organophosphorus pesticide posioning. BMJ 2007; 334:629-34.
10. Guyton AC, Hall JE. Textbook of medical physiology. 10th edition. W.B. Saunders Company; 2001: p.80-84,690_708.
11. Karki P, Hansdak SG, Bhandari S, Shukla A, Koirala SA. A Clinicoepidemiological study of organophosphorus poisoning at a rural bases teaching Hospital in eastern Nepal. Trop. Doct 2001; 31(1): 32-34.
12. Siwach SB, Gupta A. The profile of acute poisoning in Haryana. a Rohtak study. JAPI 1995; 43(11): 756-59.
13. Siwach SB, Gupta A. The profile of acute poisoning in Haryana. a Rohtak study. JAPI 1995; 43(11): 756-59.