

Effect of Occupational Exposure to Pesticides on Cardiovascular System among Farmers: A Comparative Study

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Abstract

Background: Agriculture is a very complex occupation, apart from increasing productivity also brings huge loss to community in terms of its ill effects on human health, plant and animal life. Adverse effects on cardiovascular system is likely to occur due to aggressive use of agrochemicals such as pesticides.

Objectives: To Study Changes in ECG due to pesticide exposure among farmers and to Compare these ECG Changes in those farmers with that of normal non-exposed subjects.

Materials and Method: A 12 lead ECG was recorded in apparently healthy male farmers exposed to pesticides and normal non exposed age matched male control subjects and analysed for parameters such as heart rate, PR interval, QTC interval, QRS axis, ST and T wave changes and compared.

Results: This study reports significantly increased heart rate, prolonged QTC interval and non-specific ST and T wave changes among pesticide exposed farmers compared to non-exposed control subjects.

Conclusion: The current study concludes that there is a need to detect these ECG changes as early as possible so that future risk of cardiovascular disease can be prevented by adapting precautionary measures during application of pesticides. Some form of continuous cardiac monitoring seems advisable. Farmers can be advised to quit toxic chemical fertilizers & pesticides and opt Organic ones to be safe from the hazardous implications of exposure.

Keywords: ECG; Pesticides; Farmers; Cardiovascular disease.

Introduction

Agriculture is the backbone of the Indian economy. Agriculture plays a key role in the overall economic output of a country. Since in this modern era of agriculture, because of insufficient rains and due to parched irrigation, there is a persistent crop loss due to invasion by pests, diseases and weeds before the harvest. These losses affect the livelihood of a farmer and their

families. To get best crop yield there was introduction of chemical fertilizers & pesticides. In making India a self-sufficient nation in food grain production day by day resulted in rampant usage of chemical fertilizers & pesticides bringing delineation of soil with toxic chemicals entering the food chain building-up toxicity with huge loss to community in terms of its ill effects on humans, plant and animal life due to aggressive use of agrochemicals^{[1][2]}.

Farmers, mostly being illiterate or ignorant, may not consider the precautions while using pesticides, might inhale, as well ingest or inculcate the toxic chemicals from them by one way or the other due to unhygienic conditions.

Chemicals like endosulfan, tetradifon, pyridaben,

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lead and many other organo-phosphates are present in pesticides^[3].

Cardiovascular diseases are one of the leading causes of death worldwide^[4]. Nearly 50% of world's labour force is into agricultural sector^[5]. The presence of these toxicants in farmers has the potential to affect cardiovascular health as well as electrocardiogram^[6]. The present study is designed to detect the ill effects of exposure to fertilizers and pesticides on cardiovascular function.

ECG Recording is a simple non-invasive technique. Hence, this study is taken up to detect the Electrocardiographic changes in Asymptomatic Toxicant-Exposed Farmers, to study prevalence of such abnormal ECG findings and thereby predict future cardiovascular complications as early as possible. Farmers can be advised to quit toxic chemical fertilizers & pesticides and opt Organic ones to be safe from the hazardous implications of exposure.

Methodology

This study was undertaken in 60 apparently healthy male farmers, aged between 20 to 40 years with history of working for at least 6-8 hours a day for twice a week for more than 10 years of exposure to pesticides in the farm. Sixty-two apparently healthy male, control subjects were selected randomly from general population. We approached Rural Farmers' associations and APMC Farmers' association for selection of study subjects. Subjects will be matched for age, height and weight. Subjects with History of smoking, Alcohol intake, Diabetes mellitus, Hypertension, Anemia, Abnormalities of Vertebral column and thoracic cage, Pulmonary tuberculosis, Bronchial asthma, Chronic bronchitis, other respiratory diseases, Cardiac diseases, Abdominal or chest surgery were excluded from the study.

After taking written consent and asking detailed history about pesticide exposure with series of questionnaires like type of pesticides, mixing procedure, use of protective measures like gloves and masks, frequency of application etc Institutional Ethics Committee (IEC) Clearance was obtained before beginning the study.

A detailed assessment of individual subjects was done using pre-structured pro-forma. Data acquisition

was done in the morning. A detailed physical examination of subjects was done followed by systemic examination and ECG recording. Physical examination of all the subjects included temperature, blood pressure, respiratory rate and pulse rate.

Detailed history was taken which included a comprehensive history on usage of agrochemicals

1. Type & composition (mix or solitary; pyridaben\ chlorpyros\urea\organochloride\ammonia and many other compounds)
2. Duration of usage-daily\weekly\quantity\mixture
3. Precautions considered-masks\clothing\footwear\ eye wear\post-work sanitation
4. Type of dispersal-by-hand\spray\tablets

Resting pulse rate was recorded from the radial artery. Blood pressure was recorded using a mercury sphygmomanometer with the appropriately sized cuff from the right brachial artery in supine position.

ECG was recorded in those individuals who are selected for the study. The instrument used for recording ECG is Computerized NIVIQURE Digital 12 Lead ECG machine. Special emphasis was given on Heart Rate, PR Interval, QTc Interval, QRS axis, ST Segment, T Wave changes and all parameters will be analysed. ECG signals were obtained from all the leads. The following ECG parameters have been considered in this study.

Standard ECG reference values will be taken from Wagner G.S: Interpretation of normal electrocardiogram.

Statistical Analysis: Continuous variables will be expressed as mean \pm standard deviation (SD). Categorical data will be presented as frequencies and percentages. Differences between the groups will be compared using the two-tailed unpaired student's t-test. Comparisons of categorized variables between groups will be performed using the χ^2 test. All tests of statistical significance will be two-sided and $P < 0.05$ will be considered to indicate a statistically significant difference. The statistical analyses will be conducted with SPSS 20.0

Results

The results obtained were expressed as mean \pm standard deviation. The study showed the following results which are tabulated and analysed.

Table 1: Age-wise distribution of subjects in each group

Age (Yrs.)	Farmers	Controls	Total
25-29	20	26	46
30-34	16	26	42
35-39	23	31	54
40-44	32	15	47
45	9	2	11
Total	100	100	200
Chi Square Test: P<0.000			

Table 2: Incidence Of occurrence of Heart Rate changes in farmers exposed and controls:

HR (bpm)	Farmers	Controls	Total
Normal	88	98	186
Abnormal	12	2	14
Total	100	100	200
Chi Square Test: P<0.01, Significant			

Table 3: Incidence of occurrence of changes in the ST segment in farmers exposed and controls:

A. With respect to the number of subjects showing the changes:

ST Segment	Farmers	Controls	Total
E	3	0	3
IE	97	100	197
Total	100	100	200
Fisher's exact test: P<0.003, Not Significant			

*where E-Elevation & IE-Iso-Electric

B. With respect to the leads and amplitude:

Farmers			
Lead	No. Cases	Max (Amp)	No. Cases
I	1	0.5mm	2
II	2	1mm	1
III	1		
V3	2		
V4	2		
V5	1		

Table 4: Incidence of occurrence of changes in T Wave in farmers exposed and controls

T Wave	Farmers	Controls	Fisher's exact test	Significance
I	0	0	-	-
I	0	0	-	-
III - I	2	0	P<0.311	NS
III-F	5	7		

T Wave	Farmers	Controls	Fisher's exact test	Significance
avR	0	0	-	-
avL	0	0	-	-
avF	0	0	-	-
V1	3	0	P,0.123	NS
V2	2	0	P<0.249	NS
V3	1	0	P<0.500	NS
V4	0	0	-	-
V5	0	0	-	-
V6	0	0	-	-
Total	100	100	-	-

Table 5: Comparison of QTc interval (seconds) in farmers exposed and controls

QTc	Farmers	Controls	Total
Normal	83	98	181
Abnormal	17	2	19
Total	100	100	200

Chi Square Test P<0.01, Significant

Table 6: Comparison of mean values of clinical parameters in farmers exposed and controls: Heart rate (bpm), PR interval (sec), QTc interval (sec) and QRS axis (degrees):

Groups		N	Mean	Std. Deviation	P Value	Significance
HR	Farmers	100	88.45	9.59	p<0.000	HS
	Controls	100	82.70	9.80		
PR	Farmers	100	0.14734	0.1123	P<0.870	NS
	Controls	100	0.14762	0.128		
QTc	Farmers	100	0.42241	0.142	P<0.000	HS
	Controls	100	0.38860	0.298		
QRS axis	Farmers	100	48.57	12.57	P<0.96	NS
	Controls	100	48.66	12.89		

Discussion

Cardiovascular diseases (CVD) are associated with increased morbidity and mortality rates and reduced life expectancy^[7]. Apart from the fundamental risk factors, environmental toxic substance including pesticides may affect cardiovascular system^[8]. ECG is influenced by these changes due to the exposure to pesticides. A combination of these changes and continued exposure predisposes to various cardiovascular diseases which can turn out fatal. It is essential to understand the repercussions of these occupational exposures to

pesticides and its associated future risk of cardiovascular diseases.

The current study showed the following results which is analysed as follows:

ECG Report:

Heart Rate: The incidence of occurrence of changes in Heart rate was significantly higher in the farmers exposed compared to the control group (P<0.000) (Table 2). There was a highly significant increase in the heart

rate in exposed farmers group as compared to control to the control group ($P < 0.000$)

Our finding is in consistent with other studies.

Saaddeh AM and his coworkers in their study reported increase in heart rate compared to controls^[9].

Karki P and his colleagues found significant increase in heart rate as an electrocardiographical manifestation in pesticide exposed subjects^[10].

This increase in HR could be related to the nicotinic effects of OP compounds and other agrochemicals and increased sympathetic tone^[11]. These compounds act by irreversibly inhibiting the enzyme cholinesterase, resulting in accumulation of acetylcholine at synapses and myoneural junctions leading to cholinergic over-activity^{[9][10]}.

PR interval: In this study There was no significant change in the mean PR interval (seconds) in exposed farmers group as compared to the control group ($P < 0.870$) (Table 3).

QTc interval: The mean QTc interval (seconds) in exposed farmers group was significantly prolonged compared to the control group ($P < 0.000$) (Table 6) The QTc interval tended towards the upper end of the normal range.

Wahab A and his coworkers in their study showed increased QTc interval as an effect of pesticides on cardiovascular system^[12].

Mladenka P et al reported prolonged QTc interval in pesticide exposed subjects. Since QTc interval is more important parameter than QT interval since it is corrected with heart rate, here in this study special interest is given to QTc interval^[13].

The QT Interval is an element of ECG that is a representation of ventricular function which includes depolarization and re-polarization. Measurement of QT and QTc can be used as a simple indicator for cardiovascular diseases^[14].

In this study there was prolongation of QTc interval in fertilizer and pesticide-exposed farmers group which is highly significant compared to controls. The QTc interval tended towards the upper end of the range and significant number showed abnormal QTc prolongation. The QTc interval represents duration of activation

of ventricular myocardium and its recovery. The QT interval corrected for heart rate (QTc) which is longer than 0.44 seconds is generally considered to be abnormal. The QT interval represents the duration of activation and recovery of the ventricular myocardium. Prolonged QTc interval here suggests prolonged recovery from electrical excitation which increases the likelihood of dispersing refractoriness, when some parts of myocardium might be refractory to subsequent depolarization^[12].

Prolonged QTc interval can be attributed to the due to direct cardiac toxicity (myocardial necrosis) along with the associated structural myocardial damage caused by pesticides^[13].

Studies done in animals reported that prolongation of the QT interval is a direct myocardial pesticide effect and is independent of cholinergic effects.^[9] The cardiovascular effects of organophosphorus compounds are unpredictable and often change and adverse effects increase with increase over the time course of exposure. ECG changes like QTc prolongation is potentially dangerous and indicates the requirements of continuous cardiac monitoring^[11].

ST segment: In this study non-specific ST segment elevation less than 1 mm was found out in three subjects in farmers exposed to fertilizers & pesticides but it was found to be statistically not significant compared to the normal control groups. (Table 4)

These changes are significant seen in higher dose exposures and acute poisoning^[13].

T wave changes: In our studies, changes in T wave were found to statistically not significant. But certain non-specific changes were seen in the farmers group such as inversions and flattened waves in a few leads which were low amplitude waves. (Table 5)

These non-specific changes in ST segment and T wave changes can be explained by the fact that the inorganic compounds in pesticides cause direct myocardiotoxic damage and studies have the revealed that patchy necrosis, cardiac discoloration, patchy pericarditis, auricular thrombus, right ventricular hypertrophy, myocardial interstitial oedema, vascular congestion, patchy interstitial inflammation and mural thrombus occurs in acutely exposed cases^[13].

QRS axis change: In the current study there was no significant difference in the mean QRS axis in

exposed farmers group as compared to the control group ($P < 0.960$) (Table 7)

Conclusion

The present study concluded that Occupational exposure to pesticides is the major health concern of today's society, especially among farmers as they are mostly unaware of it and it can predispose them for the development of various morbid conditions over the years. The prevalence of unreported case of cardiovascular deaths is of serious concern. The number of farmers that use agrochemicals then retired due to ill health normally die without knowing the cause of their death. The banning of agrochemicals in the agricultural sectors will produce adverse economic effects and people will suffer across the world. As in low dose chronic exposure they may not manifest clinically, and pesticides exposed subjects for long time remain asymptomatic. However, it brings Electrocardiographic changes that are noticed early over a period of exposure and the general impression is that it is advisable to detect these changes as early as possible so that future risk of cardiovascular disease can be reduced by adapting precautionary measures during application of pesticides. Therefore, some form of continuous cardiac monitoring seems advisable. Considering the gravity of this situation, more work needs to be done in this aspect. Farmers can be advised to quit toxic chemical fertilizers & pesticides and opt Organic ones to be safe from the hazardous implications of exposure.

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