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Original Research Article

Histopathological Changes in the Motor Cortex of Rat CNS after Pyrethroid Based Mosquito Repellent Inhalation – An Experimental Study

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Abstract

Introduction: The liquid vaporizers are very commonly used as residential insecticides in developing countries. Neurotoxic effects of pyrethroids have been reported earlier but studies regarding their histopathological effects on motor cortex area of cerebrum are rare. So the present study was planned to assess and compare the effects of pyrethroid based mosquito repellent inhalation in the motor cortex of rat CNS.

Method: Twenty albino rats were divided into two groups of control and experimental. Rats in experimental group were exposed to 3.2% w/v prallethrin vapours 12 hours daily for 180 days. Control animals were kept under identical conditions without exposure to said repellent. The animals were sacrificed after 180 days. Their Cerebrum removed and processed. Sections cut and stained with Haematoxylin, Eosin and thionin.

Result: Neurohistological alteration in our study in experimental rats were, loss of organisation of the cortical layer, increased density of inflammatory cells and initial signs of neuronal damage when compared to control ones

Conclusion: The findings of our study establish that pyrethroids given by inhalational route do cause neurotoxicity on chronic exposure as shown by inflammatory and degenerative changes in the histological sections of CNS.

Keywords: pyrethroid, inhalation, toxicity, histology, rat motor cortex.

1. Introduction

Prallethrin, a type-I pyrethroid is a chief constituent in insecticidal formulations intended for indoor use in developing countries[1,2] in the form of powders, sprays, impregnated papers, mats electro evaporators and coils[3] to control mosquitoes, cockroaches and other insects. Their use has risen dramatically during the last 10 years in India and other developing countries due to high insecticidal and low mammalian toxic effects[1,4-7]. As a consequence of its extensive use for agricultural and domestic purposes, there has been a concern among public regarding the routine use of this pyrethroid. Prallethrin is regularly used with its maximal human exposure for prolonged periods for atleast 8h/day[8] but there is a paucity of information concerning the effect of routine and long term use of the prallethrin based mosquito repellents in humans. Most of the previous reports are based on studies on immature mammals who received drug through different routes except respiratory. The latter being conventional route through which millions of people are exposed for several decades.

The motor cortex is a part of central nervous system that plays an important role in consciousness, awareness, thought, memory, attention and language. Therefore the present study was carried on adult male albino rats exposed to 3.2% w/v of pyrethroid based mosquito repellent inhalation for a period of 180 days to assess histological changes in the motor cortex of rat CNS.

2. Materials and Methods

The present study was carried out on adult Charles foster rats weighing between 100-150gms.

The animals were provided with standard pellet laboratory diet (Lipton India Limited) and water *ad libitum*. They were housed under identical diurnal conditions and temperature. The animals were weighed, marked and divided into two groups:

Group 1-Experimental

Group 2-Control

The experimental animals were kept in unit plastic cages (36cm x 22cm x 14cm) with many holes. They were exposed to liquid mosquito repellent inside a closed room (180cm x 240cm) according to another method[8]. The animals were exposed to 3.2% w/v prallethrin vapours for 12 hrs daily for a period of 180 days. The control animals were kept under identical conditions without exposure to 3.2% w/v prallethrin vapours. The permission to perform experiments on rats was taken from Institutional animal ethics committee.

The body weight was measured weekly and the water consumption was assessed daily.

Rats in the experimental group were exposed to mosquito repellent vapours every day for 12 hours for 180 days. At the end of exposure (after 180 days) the animals (experimental and control) were sacrificed and sections were taken from cerebral cortex (motor area) to detect the neuro-histological changes, if any. Staining reagents used for the histological preparations i.e. Haematoxylin Eosin and thionin were obtained from Department of Anatomy J.N. Medical College.

3. Observations and results

3.1 Cerebral Cortex (CC, motor area):

3.1.1 Haematoxylin and Eosin stained sections

X100 Magnification – H & E stained section of cerebral cortex (CC, motor area) of control rats showed normal layers of cortex. Individual cells were well stained and all the layers showed normal thickness. The experimental rats showed degenerative changes with lightly stained nuclei, vacuolated cytoplasm and few areas showing inflammatory cells and loss in organization of cortical layers (Figure 1.1 &1.2).

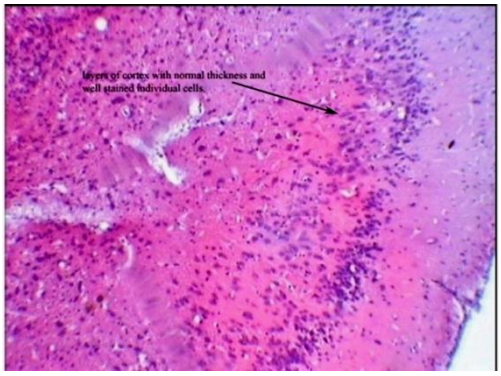

Fig 1.1: CC control. H&E (X100)

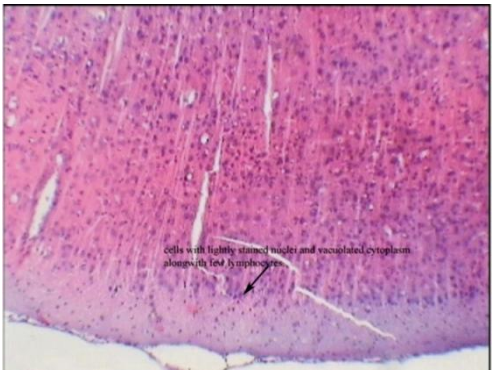

Fig 1.2: CC, exp. H&E(X100)

X400 Magnification – The control specimens showed well stained neurons with cellular architecture maintained. The experimental tissues showed lightly stained cells with loss of cellular details along with inflammatory cells (lymphocytes) in few areas (Figure 1.3 & 1.4).

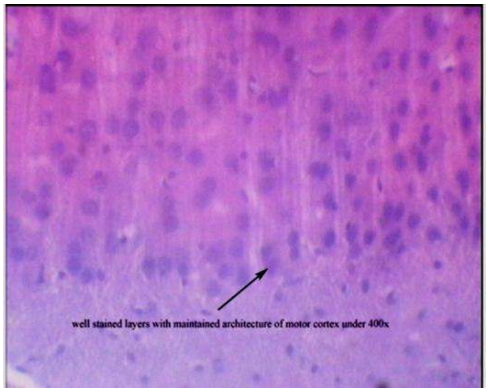

Fig 1.3: CC,control, H&E(X400)

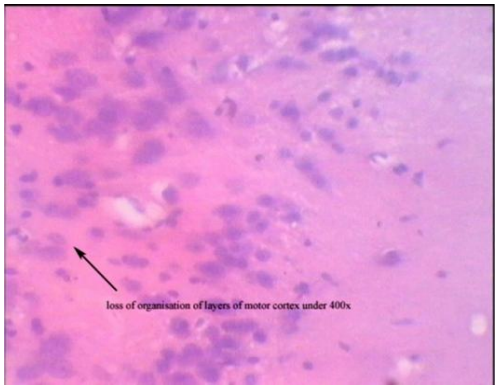

Fig 1.4:CC, exp. H&E (X400)

3.1.2 Thionin stained sections:

X100 Magnification – The control tissue showed darkly stained nuclei with cellular details well maintained. The experimental sections showed lightly stained cells with some areas indicating the presence of inflammatory cells (Figure 2.1 & 2.2).

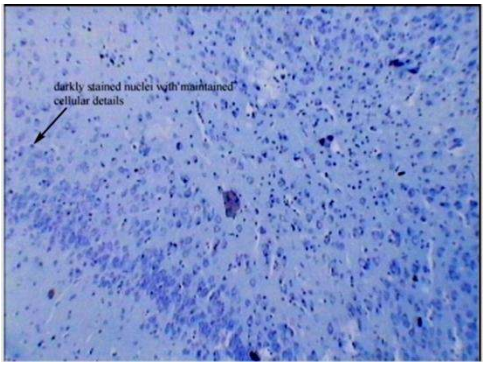

Fig 2.1: CC, control, Thionin(X100)

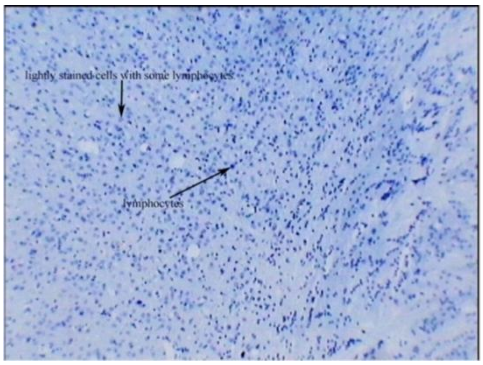

Fig 2.2: CC, exp. Thionin (X100)

X400 Magnification – The control specimens showed darkly stained nuclei having abundant Nissl's substance. The experimental sections showed lightly stained nuclei with loss of cellular details and dissolution of Nissl's substance (Figure 2.3 & 2.4).

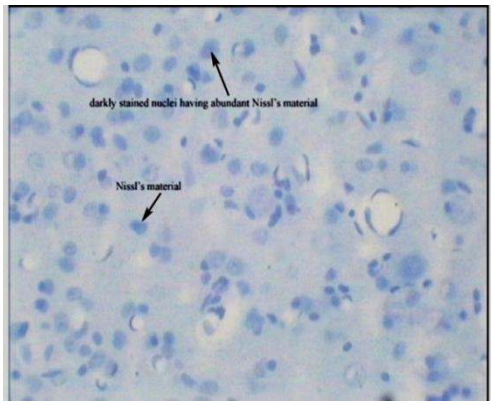

Fig 2.3: CC, control, Thionin(X400)

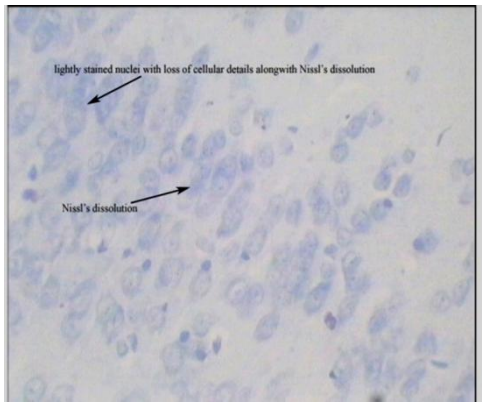

Fig 2.4: CC, exp. Thionin (X400)

4. Discussion

The primary motor cortex is one of the principal brain areas involved in motor function. It is located in the frontal lobe of the brain, anterior to the precentral sulcus. It's role is to generate neural impulses that control the execution of movement. Signals from primary motor cortex cross the body's midline to activate skeletal muscles on the opposite side of the body. Histological parameters are considered as an evidence of tissue insults by toxic compounds. Hence to study the neurotoxicity of any drug the assessments of histological damage have been conducted. In our study we took sections from motor cortex area of central nervous system. Neurohistological alteration in our study in experimental rats were, loss of organisation of the cortical layer, increased density of inflammatory cells and initial signs of neuronal damage when compared to control ones. Cell swelling, Nissl's dissolution and presence of vacuoles in the white matter of cerebral cortex were additional findings.

There was insult to the nervous tissue by pyrethrin manifested by immune photochemistry and image analysis of growth associated protein-43, a neuron specific protein present in arsenal growth cone and a marker for neuronal differentiation as per the study of Aziz[9].

5. Conclusion

The present study was carried out to find the effects of chronic inhalation of pyrethroid based mosquito repellents on central nervous system in adult rats. In the present work experimental rats were exposed to inhalational pyrethroids for 6 months to find out the extent of changes in their behaviour and neurohistology, if any.

Neurohistological sections were studied in Haematoxylin Eosin and Thionin stain. The sections were taken from cerebral cortex (motor area). The

animals were sacrificed by perfusion method at the end of exposure neurohistological changes were noted down and compared.

The neurohistological study indicated signs of inflammatory changes. There was loss of organization/disruption of layers in cerebral cortex motor area along with the presence of inflammatory cells maily lymphocytes. There was also evidence of increased vascularity, cell swelling and Nissl's dissolution. The findings of our study establish that pyrethroids given by inhalational route do cause neurotoxicity on chronic exposure as shown by inflammatory and degenerative changes in the histological sections of CNS.

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