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Effects of Mercury Chloride on the Cerebral Cortex of Adult Wistar Rats

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ABSTRACT

Mercury is among the heavy metals that have been reported to cause devastating health problem worldwide. The primary site of action of mercury chloride is the central nervous system. This study investigated the effect of mercury chloride on the cerebral cortex of adult wistar rats. Twenty-four (24) adult wistar rats were used for this study. Following four (4) weeks of acclimatization, the rats were randomly divided into five groups of five animals per group. The animals were allowed free access to food and water throughout the period of experment. Group 1 was the control group and was administered distilled water, while groups 2, 3, 4 and 5 were administer 6.6mg/kg, 13.2mg/kg, 26.3mg/kg and 52.2mg/kg body weight of mercury chloride solution orally respectively for eight (8) days. After the period of mercury chloride administration, the animals were anaesthetized using chloroform and where sacrificed. The brain was fixed in Bouin's fluid and the tissue processed and stained with haematoxylin and eocin stains and were studied under the microscope. The photomicrographs reveal distortion and diffusion of cells and a widespread necrosis of the cortical neurons.

Keywords: Mercury chloride, Cerebral cortex, Degenerative changes

Man in his environment has been exposed to many potential heavy metals through bioaccumulation and biomagnifications which has been transferred to man via food chain as a result of anthropogenic activities.

Mercury is a heavy metal that has led to many health problems in the world. It can exist as organic, inorganic and elemental mercury. The oxidation state and chemical form of mercury are important in determining its toxicity; inorganic mercury is the most toxic form. Mercury and its compounds has been evidenced in Nigeria, Minamata, Iraq, Pakistan, Guatemala and Yatsishiro via preserved grains, fishes and water which has resulted to devastating health condition (WHO and Berlin 1991, Wang 1997).

Mercury toxicity in Nigeria was reported in some fishes of Lagos lagoons, in Niger Delta, in Oyewo water (Kakulu and Osibanji 1986). In Northern Nigeria, there is toxicity via the use of traditional Kohl in States like Katsina, Sokoto and other northern states. Report also shows that the concentration of mercury exposure is more in Plateau, Kano, Kaduna, Abia, Ibadan, Lagos and Port Harcourt (Chukuma *et al* 1997, Hardy *et al* 2004).

Mercury and its compounds have been reported to have effect on the respiratory system, cardiovascular system, reproductive system, blood, hair, skin and enzymes (Goodman *et al* 1986). Some of the symptoms of mercury poisoning include irritability, excitability, restlessness, headache, dizziness, difficulty in walking, frequent urination among others (Amin-Zaki *et al* 1974).

Mercury and its compounds have been used in embalming and preservation of anthropological specimen. In agriculture, it is used as fungicides to control root maggot of cabbage and onions. And it is also used in vaccine (thimerosal) and in syrup, pills (Wang 1997). Mercuric compounds are widely used in cosmetic production, e.g. in creams, ointment, perfumes, etc. And it also has miscellaneous uses in mercury switches, liquid mirrors, batteries, thermometer and many others.

Today, the uses of mercuric compounds have greatly declined in all respect in developed countries. It has been reduced to trace level or substitute with another non-toxic substances, for example, Na+ (sodium) in use as a nuclear reactor coolant in place of mercury due to its less density and less energy to circulate a coolant.

This work was carried out to investigate the effect of mercury chloride on the cerebral

cortex of adult wistar rats in order to create awareness on the exposure to mercury and its compounds (mercuric chloride) directly or indirectly.

MATERIALS AND METHODS

Animals

Experiments were carried out on 25 adult wistar rats purchased from the Animal house of the Faculty of Veterinary Medicine, Ahmadu Bello University, Nigeria. They were kept in a plastic cage and allowed to acclimatized for four (4) weeks in the Animal house of the Department of Human Anatomy, Faculty of Medicine, Ahmadu Bello University, Nigeria. They weighed between 180 - 200g and were grouped into five (5) groups with five (5) animals in each group. They were allowed free access to food and water throughout the period of oral administration of test substance. Group 1 was the control and was administered distilled water. Group 2 was administered 6.6mg/kg of mercuric chloride orally. Group 3 was administered 13.20mg/kg body weight of mercuric chloride, while groups 4 and 5 were administered 26.3mg/kg and 52.2mg/kg respectively. The route of administration was oral and administration lasted for eight (8) days. Dose administered was based on the oral LD_{50} of mercuric chloride which was reported to be 210mg/kg (Leon *et al* 1977).

Drug Used for Study

Mercuric chloride manufactured by May and Baker Limited Dagenham England was purchased from Steve Moore Chemicals, Zaria, Nigeria.

Histological Procedure

At the end of administration, the animals were anaesthesized using chloroform. The brain was excised and fixed in Bouin's fluid. The brain tissues were dehydrated in alcohol with ascending concentration of 70%, 80%, 90%, 95% and 100% at an interval of one hour for each stage of dehydration.

Cleaning of the tissue was done using xylene before infiltration with molten paraffin wax. Sections, each of 7-11 microns were cut from the embedded tissues using a rotatory microtome. Thereafter, they were mounted on glass slides in the presence of egg albumin, dried at room temperature and stained alternately with haematoxylin and eosin. The slides were examined under the microscope at the magnification of x25 and photographs taken using Amscope optical eye piece.

RESULTS

Physical Observation

The control group (i.e. Group 1) did not show any reaction. But the treated groups (i.e. Groups 2, 3, 4 and 5) showed reactions to the test substance. The reactions ranging from mild to pronounced. They where seen passing viscous faeces, gnawing, mucus secretion and reduction in physical activities.

Histological Observations

The treated section of the cerebral cortex of the control group 1 shows the animal histological features of the cerebral cortex. The pyramidal cells (PC), stellates cells (SC) and the molecular cells (MC) are all intact as shown in Figure 1. The treated group 2 that received 6.6mg/kg body weight of mercuric chloride showed diffused pyramidal cells (DPC), dead cell (DC) as shown in Figure 2. The treated group 3 that received 13.3mg/kg body weight of mercuric chloride showed diffused stellate cells (DSC), mild congestion, pyramidal and stellate cells (SC) as shown in Figure 3, while group 4 that received 26.3mg/kg body weight of the test substance showed severe degenerated neurons and dead cells (DC) as shown in Figure 4. And the group that received the highest dose of mercuric chloride i.e. group 5, 52.5mg/kg body weight showed widespread of congestion (CGS), clumping and distortion of both pyramidal and stellate cells.

DISCUSSION

In this study, mercury chloride led to reduction in physical activities in all the treated

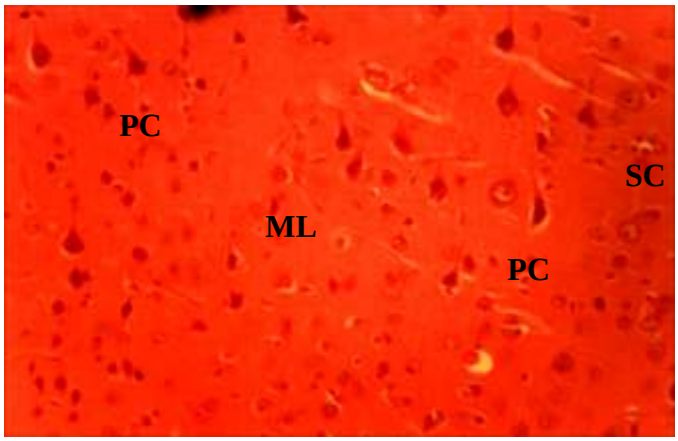

Fig 1: Photomicrograph of transverse section of the cerebral cortex showing pyramidal cells (PC), Stellates cells (SC) and molecular layer (MC) of the control group. Cells are intact, H&E, x250.

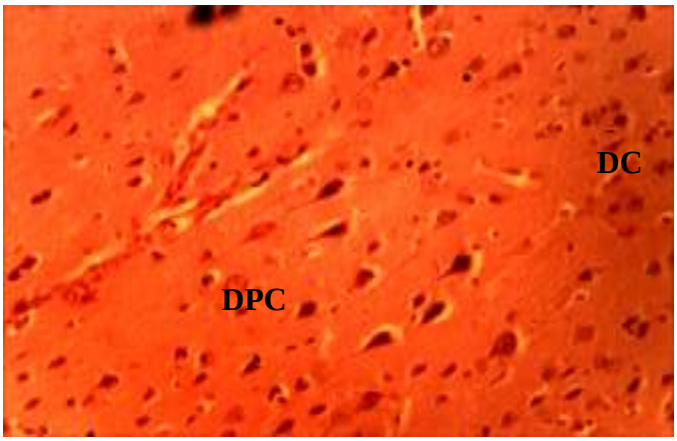

Fig 2: Photomicrograph of the transverse section of cerebral cortex of the treated group receiving 6.6mg/kg showing diffuse pyramidal cell (DPC), death cell (DC), H&E, x250.

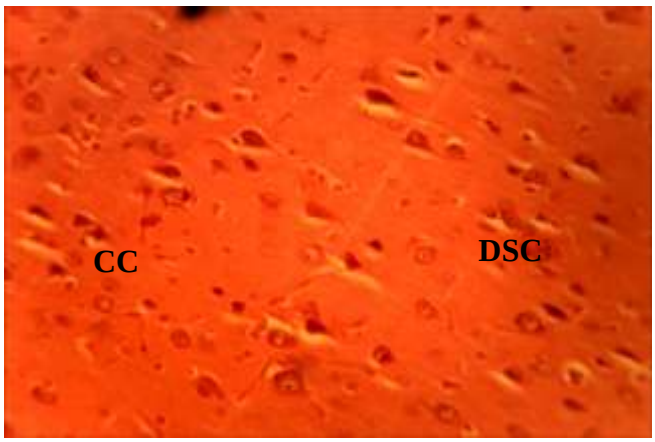

Fig 3;Photomicrograph of the transverse section of cerebral cortex receiving 13.3mg/kg with(DSC) diffused stallate cells mild congestion of cells (CC) pyramidal and stallate cells. H & E x 250

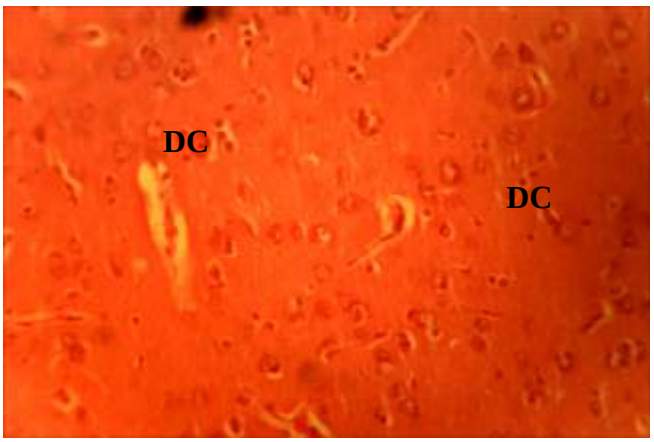

Fig 4: Photomicrograph of the transverse section of the cerebral cortex (internal granular layer) of the treated group receiving 26.3mg/kg with severe degenerated neurons. H & E x 250
satelitetosis and (DC) death cells, H&E, x250.

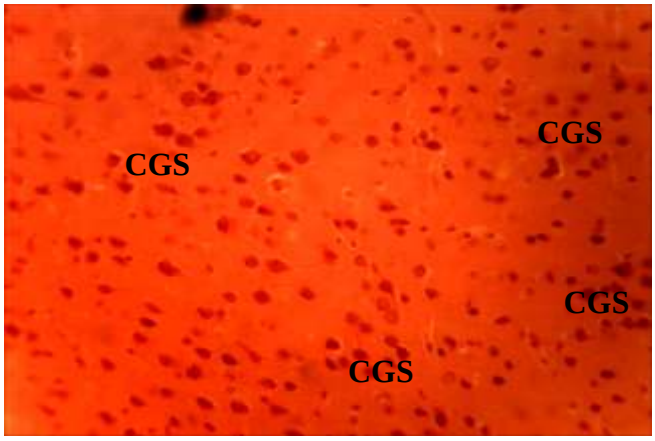

Fig 5: Photomicrograph of the transverse section of cerebral cortex of the group receiving 52.5mg/kg with wide spread of (CGS) congestion, clumping and nuclei distortion of both pyramidal and Stellates cells .
H&E x 250.

groups (i.e. groups 2, 3, 4 and 5) some of the characteristics of mercurialism was pronounced. It was observed that there is satellitolosis, gliosis and neuronal degeneration in the treated groups when compared with the control group that was administered distilled water. Satelitosis occurs because when a cell has been assaulted and is about to die other neurons come around waiting for it to die and then eat it off, while gliosis is a process whereby neurons around a dead cell clumps around it and eat it up. And the neuronal degeneration was seen in terms of widespread necrosis, congestion and clumping of cortical cells. Neuronal

degeneration can be in terms of diffusion of cells, alteration in the structure of either axons or dendrites, to completely loss of branching pattern and arrangement of cells in the cerebral cortex which ranges from mild to severe damage whereby some of the cells cannot be properly identified. This observation agrees with Fukuda (1971) and Leon *et al* (1979). The signs and symptoms of mercurialism agree with the work of Amin-zaki *et al* (1974).

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