Effects of Aluminium Chloride on the Histology of Cerebellum of Wistar Rats

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Abstract

Aluminium compounds are used in pharmaceuticals and in water treatment processes. Exposure to aluminium is inevitable in this modern life. The purpose of this study was to evaluate the possible effects that aluminium chloride could have on the histology of the cerebellum of Wistar rats. Ten Wistar rats were used for this study, and they were divided into two groups. Group I was the control that received distilled water only while group II received 40mg/kg of aluminium chloride for duration of four weeks. After four weeks of administration of aluminium chloride except for the group I that received distilled water only, the Wistar rats were humanly sacrificed and brain tissues removed, fixed in Bouin’s fluid, processed and stain in Haematoxylin and Eosin. The slides were viewed under the light microscope fitted to a digital camera and Laptop. Our observations showed Purkinje cell loss in the aluminium treated group when compared with the control. We therefore conclude that aluminium chloride had neuro-degenerating effects on the cerebellum of Wistar rats as eminent in the Purkinje cell loss.

Keywords: Cerebellum, histology, neuro-degenerating, Aluminium Chloride, Wistar rats, Purkinje cell loss.

Introduction

Aluminum is a trivalent cation found in its ionic form in most kinds of animal and plant tissues and in natural waters everywhere (Jiang, et al., 2008). It is the third most prevalent element and the most abundant metal in the earth's crust, representing approximately 8% of total mineral components.

Aluminium chloride (AlCl₃) is a compound of aluminium and chlorine. The solid has a low melting and boiling point, and is covalently bonded. It sublimes at 178°C. Molten AlCl₃ conducts electricity poorly, unlike more ionic halides such as sodium chloride. It exists in the solid state as a six-coordinate layer lattice.

The cerebellum is a region of the brain that plays an important role in the integration of sensory perception and motor control. In order to coordinate motor control, there are many neural pathways linking the cerebellum with the cerebral motor cortex (which sends information to the muscles causing them to move) and the spinocerebellar tract (which provides proprioceptive feedback on the position of the body in space). The cerebellum integrates these pathways, like a train conductor, using the constant...
feedback on body position to fine-tune motor movements. Because of its large number of tiny granule cells, the cerebellum contains more than 50% of all neurons in the brain, but it only takes up 10% of total brain volume.

The cerebellum receives nearly 200 million input fibers; in contrast, the optic nerve is composed of a mere one million fibers. It receives inputs from cortex and spinal cord and from visual, auditory, and vestibular nuclei. Outputs are to the descending tract to control motor execution, to motor and premotor cortices for motor planning, and to the vestibular nuclei for balance and eye movements.

The cerebellar cortex is divided into three layers. At the bottom lies the thick granular layer, densely packed with granule cells, along with interneurons, mainly Golgi cells but also including Lugaro cells and unipolar brush cells. In the middle lies the Purkinje layer, a narrow zone that contains the cell bodies of Purkinje cells and Bergmann glial cells. Purkinje cell is large type of neuron which is found in a layer in the cerebellum. At the top lies the molecular layer, which contains the flattened dendritic trees of Purkinje cells, along with the huge array of parallel fibers penetrating the Purkinje cell dendritic trees at right angles. This outermost layer of the cerebellar cortex also contains two types of inhibitory interneuron’s, stellate cells and basket cells. Both stellate and basket cells form GABAergic synapses onto Purkinje cell dendrites.

The purpose for this study was to evaluate the possible effects that aluminium chloride could have on the histology of the cerebellum of Wistar rats.

Materials and Methods

Materials: Wistar rats, Syringes, needles, Aluminium chloride, Distilled water, Wistar rats, cages, chloroform, Beakers, Dissecting kit, Dissecting tray, Pelletized grower feed, cotton wool, Haematoxylin and Eosin stains, Bouin’s fluid, Light microscope, Tissue processing reagents, Digital camera and laptop.

Methodology: Ten Wistar rats were used for this study. They were procured from the faculty of veterinary medicine animal house, Ahmadu Bello University, Zaria. The Wistar rats were kept in the department of human anatomy animal house, Ahmadu Bello University, Zaria for a period of two weeks before the commencement of administration of Aluminium chloride so as to enable them acclimatize to the new environment. They were fed with pelletized grower feed and allowed taking water freely throughout the experiment. The Wistar rats were divided into two groups of five Wistar rats each. Group I served as the control that received distilled water only while group II received 40mg/kg of Aluminium chloride for a duration of four weeks.

After expiration of four weeks of administration, the Wistar rats were humanely sacrificed and brain dissected was fixed in Bouin’s fluid and latter the cerebellum was removed. The cerebellum was transferred into an automatic tissue processor where they went through a process of dehydration in ascending grades of alcohol 70, 80, 95% and absolute alcohol for 2 changes each. The tissues were then cleared in Xylene and embedded in paraffin wax. Serial sections of 5 micron thick were obtained using a rotary microtome. The tissue sections were deparaffinised, hydrated and stained using the routine haematoxylin and eosin staining method. The stained sections were examined under the light microscope fitted to a laptop and digital camera for photomicrographs at 40 and 250 magnifications.
Results and discussion

It is not an overstatement to aver that the modern technological age could not have occurred without the availability of aluminium. Human exposure to Aluminium has been increasing over the last decades. Patients on dialysis or on long-term treatment with total parenteral nutrition have been shown to accumulate this metal in different organs \(^{10,11,12}\).

Our present study showed normal histology of the cerebellum of Wistar rats in the group I that received distilled water only (Plates I and II) while the cerebellum of the aluminium treated group revealed sparse molecular layer and Purkinje cell loss (Plate IV) when compared with the control (Plates I and II).

Aluminium chloride was said to have negative effects on behavioural endpoints of wistar rats (i.e. alters behaviour)\(^{13}\), have negative effects on anxiety-related behaviour of wistar rats as it increased the rate of anxiety in aluminium treated rats \(^{14}\), had neurodegenerative effects on the histology of cerebral cortex of adult wistar rats especially at higher dose \(^{15}\), and have detrimental effects on the integrity of the testes of wistar rats \(^{16}\).

The above findings were in agreement with this present study where neuro-degeneration of the cerebellum (Purkinje cell loss) was observed in the aluminium treated group (Plate IV) but was in contrast with another finding that stated that aluminium chloride did not result into infertility \(^{17}\).

Conclusion

Based on our observations, we therefore conclude that aluminium chloride exposure had neuro-degenerating effects on the cerebellum of Wistar rats, as eminent in the Purkinje cell loss and sparse molecular layer.

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