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REGIONAL DISTRIBUTION OF ALUMINIUM IN THE RAT BRAIN: INFLUENCE OF VITAMIN E

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Introduction

It has been hypothesised that aluminium neurotoxicity is the cause of dialysis dementia (Salusky *et al*., 1991). The presence of aluminium in dialysis fluids may contribute to this neuropathology. Brain tissue is susceptible to peroxidative damage because of its high lipid content, high oxygen tension, low cellular mitotic rate, low antioxidant capacity and high iron content (Evans, 1993). In this communication we report the influence of vitamin E, an antioxidant, on aluminium distribution in the various regions of rat brain.

Methods

EXPERIMENTAL ANIMAL MODEL:

Male Wistar albino rats weighing 170–180g were randomized to one of the following experimental groups, with 5 animals per group:

(a) Rats were injected with an aqueous solution of aluminium lactate (Johnson Matthey GmbH, Zeppelinstraße 7, Karlsruhe), at a dose of 10 mg aluminium per Kg body weight per day given as an i.p. injection five times per week for 4 weeks, and received a standard chow diet during this time.

(b) A control was injected with similar volume of normal saline over the same period and received a standard chow diet *ad libitum*.

(c) Rats were injected with aluminium at the same dose as for (a) but received a chow supplemented with 5, 15, and 20 mg/g, of α-tocopherol (Sigma Chemical Company Poole, Dorset).

(d) A further group received 20 mg/g vitamin E supplemented diet without receiving i.p. aluminium.

All animals were individually weighed and examined daily, with food and water intakes recorded. They were all housed in polypropylene cages to avoid extraneous trace element contamination. Animals were killed by anesthetic overdose using sodium pentabarbitone (100 mg/Kg). Blood was withdrawn via the dorsal vena cava into lithium heparin tubes. The brain was quickly excised, rinsed with cold 0.14 M NaCl and dissected into identifiable regional segments, namely cortex, cerebellum, medulla, hippocampus, striatum and hypothalamus for measurement of aluminium. Brain tissue was removed, weighed and stored in aluminium-free plastic containers at –80°C, until analysis.

ALUMINIUM ANALYSIS:

The samples were digested with 90% nitric acid and 70% perchloric acid for measurement of aluminium as previously described (Taylor and Walker, 1992). Aluminium in plasma or in digested brain samples was

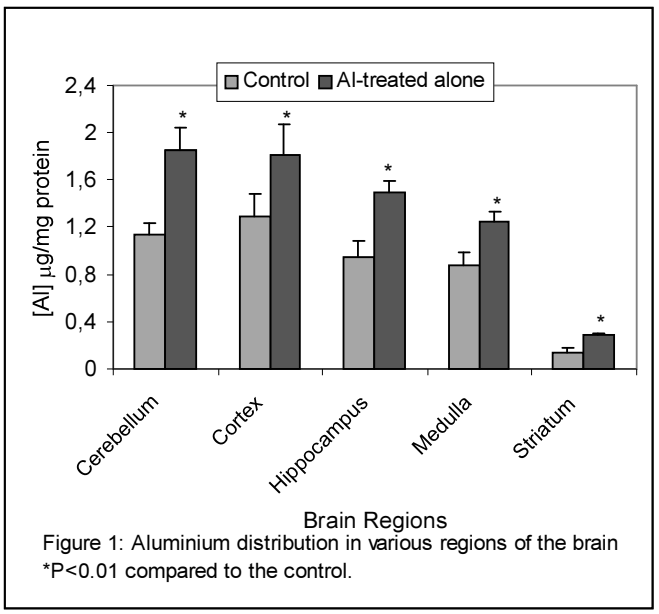

Figure 1: Aluminium distribution in various regions of the brain
*P<0.01 compared to the control.

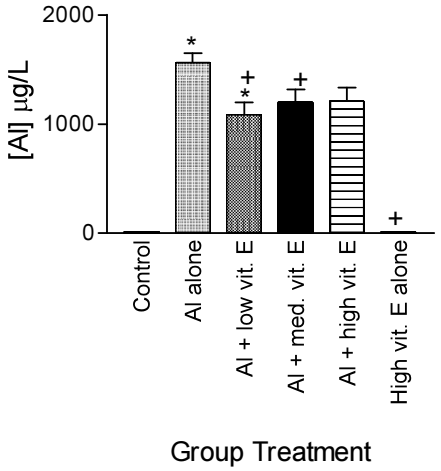

Figure 2: Plasma aluminium level in different group treatment. Values are means ± SEM for n = 5.
*P<0.01 compared to control.
+P<0.001 compared to Al alone.

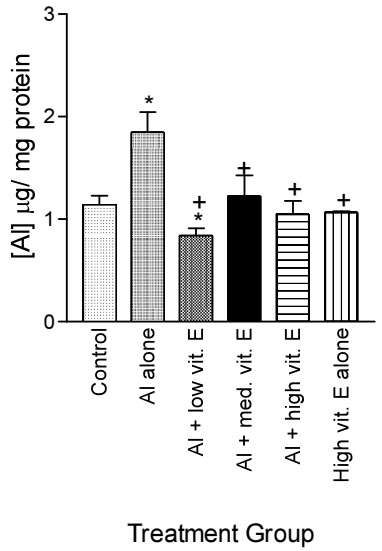

Figure 3: Brain Cerebellum Aluminium level in different group treatment. Values are means ± SEM for n = 4.
* P < 0.01 compared to control
+ P < 0.001 compared to Al alone.

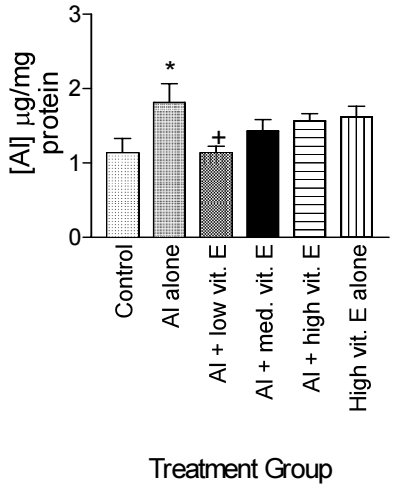

Figure 4: Brain Cortex Aluminium level in different group treatment. Values are means ± SEM for n = 4.
* P < 0.01 compared to control
+ P < 0.001 compared to Al alone.

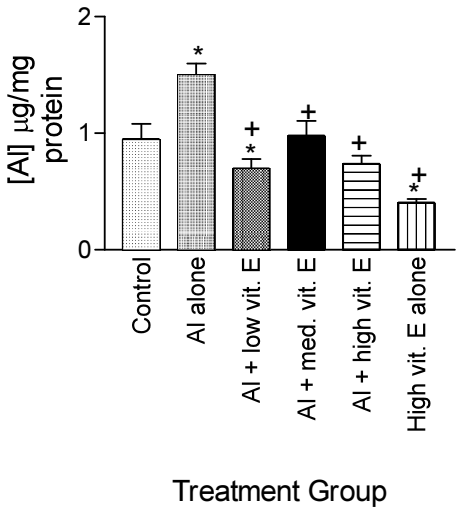

Figure 5: Brain Hippocampus Aluminium level in different group treatment. Values are means ± SEM for n = 4.
* P < 0.01 compared to control
+ P < 0.001 compared to Al alone.

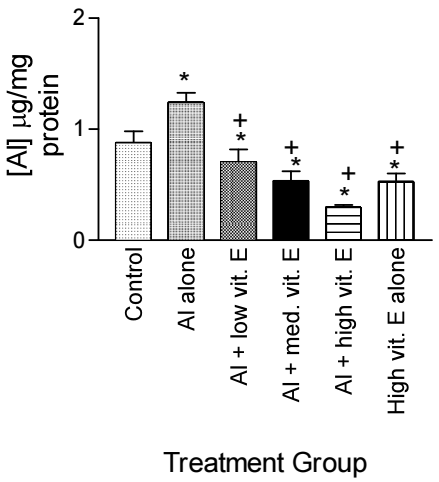

Figure 6: Brain Medulla Aluminium level in different group treatment. Values are means ± SEM for n = 4.
* P < 0.01 compared to control
+ P < 0.001 compared to Al alone.

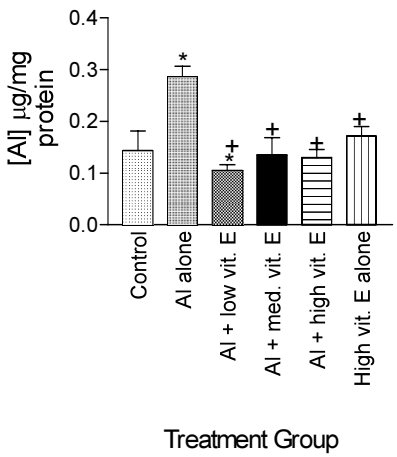

Figure 7: Brain Striatum Aluminium level in different group treatment. Values are means ± SEM for n = 4.
* P < 0.01 compared to control
+ P < 0.001 compared to Al alone.

determined by electro-thermal atomic absorption spectrometry (ETAAS).

Results

Fig. 1 shows the tissue levels of Al in different regions of the brain of rats from the control and Al-treated groups receiving normal chow. There was a statistically significant ($P<0.01$) accumulation of Al in the various regions of the brain of Al-treated rats compared to the control group. Al-accumulation was found to be greatest in the cerebellum followed by the cortex, hippocampus, medulla, and striatum.

Co-administration of dietary vitamin E was associated with a significant ($P<0.01$) reduction in Al concentration in all regions of the brain experimental (Figs 2–7).

Discussion

Many studies have linked the accumulation of Al in brain with Alzheimer's disease, and other forms of dementia. However it is unclear how Al accumulation comes about and what factors may modify this. In the present study we have investigated the influence of dietary vitamin E on the regional distribution of Al in of the rat brain.

Al administration resulted in a significant increase in both plasma and brain Al content, whether given with or without dietary vitamin E supplementation. These results are in agreement with a previous report by Julka and Gill (1996). The attenuation in Al accumulation observed in all the groups receiving concomitant dietary vitamin E may be due to vitamin E's scavenging potential. This may preserve cell membrane function including ion transport and membrane fluidity. It may also prevent the release of Fe^{2+} and Mg^{2+} from their binding proteins, potentially decreasing the rate of lipid peroxidation. Fe^{2+} ions causes membrane fragility and depletion of antioxidants (Oteiza, 1994; Barsacchi *et al*., 1992). The effects of vitamin E may be linked to its chain breaking antioxidant properties (Barsacchi *et al*., 1992).

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