

Full Length Research Paper

The Effect of Zinc and aluminum chloride in lactation period on coordination and motor activity of parents and their offspring

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Abstract

In the present study, the effects of zinc and aluminum chloride administration on coordination and motor activity of their male and female offspring have been investigated by using Rotarod for assess animal's motor activity and coordination. Aluminum administered as $AlCl_3$ (0, 200, 400, 600, 800 mg/kg/day) and zinc as $ZnCl_2$ (0, 20, 30, 50, 70, 100 mg/kg/day) in drinking water for two weeks during lactation, and their female and male offspring were tested respectively after 44 days and one month. The results showed that maternal dietary exposure Zinc consumption (20, 30, 50, 70, 100 mg/kg/day) don't have effect on motor activity of their female offspring. Also, Aluminum consumption (200,400,600 mg/kg/day) don't have effect on motor activity of their offspring but 800 mg/kg/day significantly ($p<0.05$) impairs motor activity. These studies have demonstrated that consumption of 800 mg/kg/day $AlCl_3$ during lactation, can impairment coordination of their male and female offspring. But different doses of $ZnCl_2$ administration don't have effect on motor activity on their male and female offspring.

Keywords: Coordination, aluminum, zinc, offspring, maternal.

INTRODUCTION

Zinc is an important trace element for normal cell growth and development in mammalian species. During development, zinc is important for normal morphogenesis of the central nervous system, and it appears to play a functional role in regulating the release of neurotransmitters such as γ amino butyric acid, acetylcholine and glutamate. Neonatal dietary zinc deficiency in artificially reared rat (Sanstead et al., 2000; Wouben et al., 1999). Most studies involving dietary zinc restriction or supplementation have been conducted during critical periods of rapid brain development, such as in uterus or early postpartum (Keller et al., 2001). The requirement for zinc during lactation is greater than those during pregnancy, especially during the early week post-

partum. Therefore, lactation poses a significant threat to maternal zinc homeostasis, particularly in populations with chronically low dietary zinc intakes (Krebs, 1998). Also, zinc may play a physiologically and pathophysiologically important role in the regulation of bone metabolism (Zhong et al., 2000). In some studies, zinc supplementation had a greater impact in males than in females, but this finding was not consistent in all of trials that identified a significant impact of zinc supplementation. Males have a higher percentage of total body weight comprised of muscle, which in turn contains a higher content of zinc than fat. Additionally, the growth rate of male is generally higher than females, so their zinc requirements are probably greater (Hotz et al., 2004). On the other hand, aluminum toxicity was initially recognized as a neurological and skeletal disease which occurred in some dialysis populations, it has been demonstrated that concentrations of this element that are toxic to many biochemical processes are also found in a

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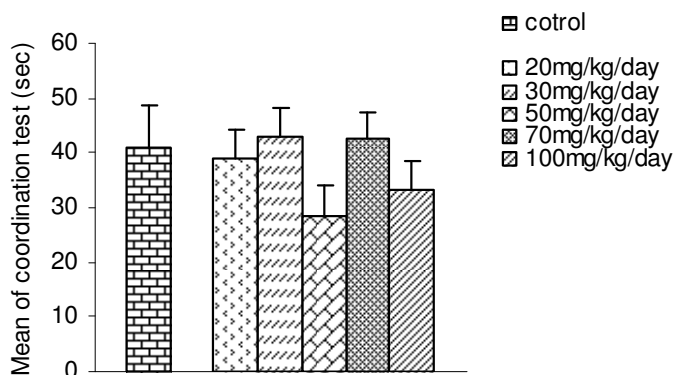


Figure 1. The effect of maternal dietary ZnCl₂ consumption on mean of coordination test (sec), in their female offspring, n=8.

number of neurodegenerative disorders affecting nonuremic and nondialyzed individuals (Daniel, 2007). Evidence reported in the last few years has shown that aluminum is a neurotoxic agent in some species, inducing neurofibrillary tangles, dendritic atrophy, and behavioral deterioration (Petit et al., 1985).

Cognitive and motor developments during infancy form the basis for children's subsequent development and are influenced by both biological and environmental factors (Maureen et al., 2004). Moreover, aluminum has been proposed as a contributor to the pathogenesis of serious neurological disorders such as Alzheimer's disease (AD), amyotrophic lateral sclerosis and parkinsonism – dementia of Guam (Domingo et al., 2000). Thus, the objectives of the current study were to test the effects of maternal zinc supplementation and aluminum intake on behavioral development of their male and female offspring.

MATERIAL AND METHODS

Animal

20 male and 60 female of adult wistar rats (200±30gr) were taken for these experiments. They were maintained in a 12 h light: dark cycle and temperature- controlled (22-25°C) animal room (Wang et al., 2001). All animals were provided from Ahvaz University of Medical Science animal house in Iran. For time mating, were placed in cages with males. Then female rat were separated from male rats. Rats in their lactation period received zinc chloride (20, 30, 50, 70, 100 mg/kg/day) and aluminum chloride (200, 400, 600, 800 mg/kg/day) in drinking water for two weeks and control groups received normal drinking water. Then dams and their litters were housed in stainless cages and divided into 11 groups (n=8). All

litters were weaned respectively at 25, 37 days and, fed ad lib and given tap water until male and female offspring were tested respectively after one month, 44 days (Keller et al., 2001).

Apparatus

Rotarod has been used for coordination and motor activity of male & female offspring. The rotarod test as performed as described. Rats were placed on a stationary cylinder (rotarod; Hugu Instruments). After 3sec, the rotarod was switched on to a speed of 4 rpm, and the rat were timed until they fell, with a maximum cut – off of 60 s. Rat were tested for three trails in succession, with 1 min between trails (Cole et al., 2001).

Data have been analyzed by one way analysis of variance (ANOVA) for testing rotarod which followed by post hoc test. The level of significance was set at $p < 0.05$.

RESULT

Our data shows that there were no significant different between where mothers received ZnCl₂ (20, 30, 50, 70, 100 mg/kg/day) at the stage of lactation and control groups of their female (Figure 1) and male (Figure 2) offspring.

On the other hand, our data shows that there were no significant different between rats control group and rats where mothers received AlCl₃ (200, 400, 600, mg/kg/day) at the stage of lactation and control groups of their female (Figure 3) and male (Figure 4) offspring ($P < 0.05$). But, in this step, there were significant differences between rats that their mothers received aluminum chloride (800mg/kg/day) at the stage of lactation and control of their female (Figure 3) and male (Figure 4) groups.

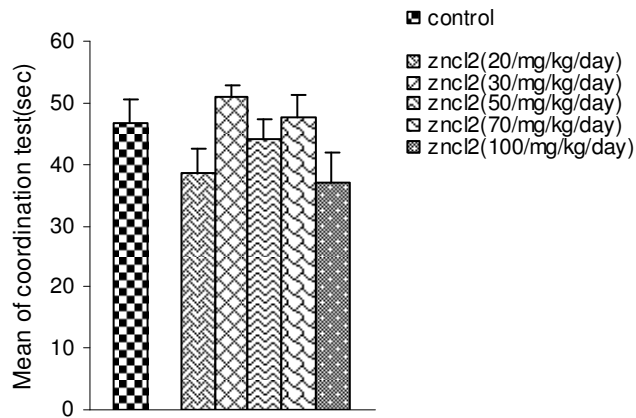


Figure 2. The effect of maternal dietary ZnCl₂ consumption on mean of coordination test (sec), in their male offspring, n=8.

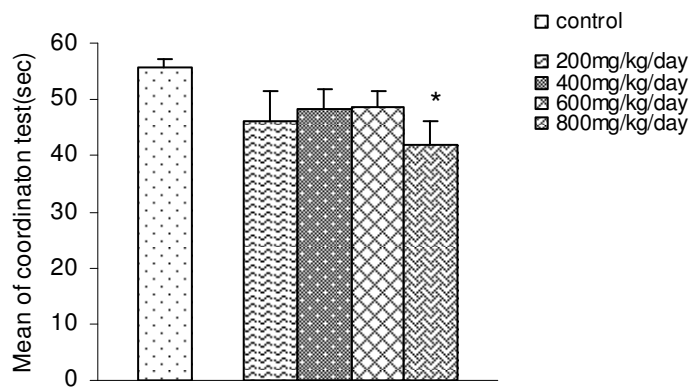


Figure 3. The effect of maternal dietary AlCl₃ consumption on mean of coordination test (sec), in their female offspring, n=8, P<0.05.

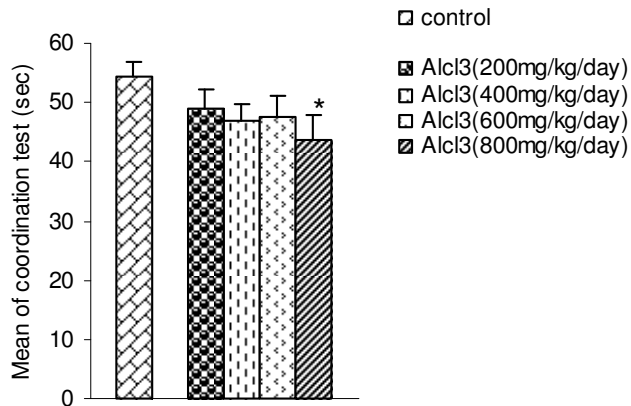


Figure 4: The effect of maternal dietary AlCl₃ consumption on mean of coordination test (sec), in their male offspring, n=8, P<0.05

DISCUSSION

Zinc is known to be an essential element for the growth of humans and other animals. Most of the study is based on the deficiency this nutritional matter is caused damaged central nervous system in animals during lactation (Zhong et al., 2000). On the other hand Aluminum is highly toxic to the growth and development of fetuses and sucklings in humans and experimental animals. This element is a potential neurotoxin, and degenerates nerve cells in the brain (Yumoto et al., 2000). So in the present study, the effects of Aluminum and zinc chloride on motor activity during lactation of rats were carried out in their offspring by using of rotarod for assess animal's motor activity and coordination. lactating rats batches Aluminum administered as $AlCl_3$ (0, 200, 400, 600, 800 mg/kg/day) and zinc as $ZnCl_2$ (0, 20, 30, 50, 70, 100 mg/kg/day) in drinking water during lactation for two weeks, and their offspring's were tested respectively after 44 days and one month. Received data showed that 20, 30, 50, 70 and 100 mg/kg/day of zinc supplementation didn't have any significant effect on coordination in their female and male offspring rats. This result is similar to the results of many other investigators. For instance, Wauben et al have shown that zinc deficiency significantly reduced growth rates and lowered the overall performance scores on locomotor's skills tests. In contrast, other trails have found no differences or negative findings related to zinc supplementation during infancy on measures of motor (Maureen et al., 2004). Several reports concluded that milk zinc concentrations are not influenced by maternal dietary intake (Krebs et al., 1995). On the other hand, have reported the presence of ZnT-1 immunoreactivity in areas that lack synaptic zinc- containing terminals, e.g., cerebellum (Sekler et al., 2002). Also, studies have shown that expression of the zinc transporter, znT-1, in the forebrain is dramatically up – regulated after birth in parallel with the rise in synaptic zinc. The increased expression of znT-1 during development, then, can be attributed to an increased neuronal zinc load. In the cerebellum, regulation of znT-1 may be also related to zinc, though from a non- synaptic source (Nitzan et al., 2002). Meanwhile, the lactation of maternal rats orally administered zinc sulfate produced a significant increase in alkaline phosphatase activity, calcium, and DNA content in the femoral- diaphyseal and metaphyseal tissues obtained from 7 – 14 day old newborn rats, suggesting the development of bone growth (Zhong et al., 2000). Also, bone growth factors may be involved in the stimulation of bone growth of newborn rats. Zinc has been shown to increase the production of insulin- like growth factor I (IGF-I) (Asahina et al., 1999; Gazzero et al., 1998). In summary, the results of this study suggest that short term zinc supplementation does not the effect on locomotor's development in offspring rats. On the other hand, maternal dietary exposure $AlCl_3$ (200, 400,

600mg/kg/day) during lactation, there were no significant effect on motor activity of their female and male offspring but 800 mg/kg/day significantly ($p<0.05$) impair motor activity of their female and male offspring. Our results confirms by some studies which reported that high brain aluminum levels are associated with rapid general activity, decreased ability to maintain rotarod activity. High serum levels of aluminum in elderly humans are associated with impaired visuo-motor coordination (Bowdler et al., 2002). Lal et al., 1993 show that high does aluminum in drinking water as $AlCl_3$ decreased locomotor activity, increased brain lipidperoxidation, decreased brain Mg-ATPase and Nak-Atpase. This could indicate that the delay on postnatal development following Al exposure is due to an Al accumulation in the fetuses, rather than Al absorption from the milk of the dam. I seem, a lack of remarkable Al transfer with lactation would not necessarily indicate that elevated Al in milk does not cause adverse effects on the offspring (Domingo et al., 2000). In addition, a number of studies conducted in rats and mice show that maternal oral Al exposure can alter performance on a neurobehavioral test battery, and reduced forelimb and hind limb grip strength (Rondeau et al., 2000; Bernuzzi et al., 1989). Also, in the postnatal period, reduced pups weight gain and effects on neuromotor development and behavior can occur as a consequence of maternal and developmental Al exposure (Domingo et al., 2000). Indeed, manifestation of aluminum toxicity and bone disease arise frequently in premature infants for reasons other than aluminum exposure (Bishop et al., 1997). Aluminum induces neural apoptosis in vivo as well as in vitro. Furthermore, a relationship between aluminum and the iron-homeostasis or calcium-homeostasis has been suggested. Based on these findings, the characteristics of aluminum neurotoxicity are reviewed, and neurodegenerative diseases are reconsidered (Kawahare, 2005). These studies show that chronic oral aluminum administration to rats has significant neurochemical consequences. Three sites of action are implicated Altered calcium homeostasis, enhanced cyclic AMP production, and changes in cytoskeletal protein phosphorylation states and concentrations (Jope and Johnson., 1992). Studied show that Al administered to lactating rats is transferred to their offspring through maternal milk (Yumoto et al., 2000). In conclusion, These results show that maternal dietary $ZnCl_2$ or $AlCl_3$ consumption during lactation have the some effects on motor coordination in their female and male offspring.

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