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Histopathological and Nutritional Physiological Study on Dietary Magnesium Deficiency in Rats

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Summary

Epidemiologically, it has been suggested that dietary magnesium deficiency is associated with the risk of heart diseases. In our previous histopathological study, magnesium deficient rats were observed significant changes of muscular cells in hearts, indicating the great similarity with pathological lesions which are often found in the early stage of ischemic heart diseases. At the first year in this project study, we observed negative effects of the dietary magnesium deficiency on living organisms, especially vacuolation of mitochondria, enlargement, rupture of myofibrils, myolysis, and accumulation of muscular particulate glycogens in cardiomyocytes. In addition, indirect calorimetric measurements by continuous registration of oxygen consumption and carbon dioxide exhalation to estimate metabolic function were examined. Those indicators in magnesium deficient group were always tended to be higher than those in control group. These findings suggested that magnesium deficiency is causing stress which may induce secretion of adrenomedullary hormones, catecholeamine, especially adrenaline. Hence, at the second year, we focused on the effects of magnesium deficiency on adrenal gland and found diffuse enlargement in adrenocortical cells. Serum ACTH, cortisol, noradrenaline, dopamine concentrations in magnesium deficient rats were tended to be higher than in control group. These results suggested magnesium deficiency itself is stress to individuals. The improvement of serum ACTH, cortisol, and dopamine concentration during a period of recovery by administering oral Mg were also observed, indicating this stress induced by Mg deficiency.

The effect of Mg deficiency on the anterior pituitary was investigated immunohistologically and ultrastructurally in this year. Experimental animals were divided into 2 groups of each six animals, Mg deficient group and Control group. Experimental diets were followed composition of AIN-93G. Control diets contained MgO and Mg deficient diet contained mineral mix except MgO. Rats were fed for 4 weeks, then sacrificed. Blood samples were examined biochemical measurements, and also pituitary and adrenal were provided for histopathological examination. Serum Mg considered as an indicator of body Mg status in Mg deficient group was significantly lower than it in Control group, indicating rats Mg deficient group were apparently Mg deficient. The weight of pituitary in Mg deficient group was tended to be higher compared to Control group. Labelled Ratio of ACTH positive cells in the anterior pituitary in Mg deficient group was significantly higher than it in Control group. In addition, development and dilated rough surfaced endoplasmic reticulum, vacuolation and enlargement of mitochondria, and adenocorticotrophic hormone immature secretory granules in Mg deficient rats were observed, while the anterior pituitary in Control group was ultrastructurally normal. These results showed that the severe changes in pituitary were occurred in Mg deficiency, suggesting changes in hypothalamus also. The further researches are necessary to solve this point.