Adaptive regulation of vesicular glutamate transporter (DNPI) gene expression in vasopressinergic neurons to salt intake—the self-regulation of hormone secretion by intrinsic glutamate

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Summary

Glutamate is an excitatory amino acid that acts as a major neurotransmitter throughout the brain. Recently, we discovered a novel inorganic phosphate cotransporter (DNPI), which attracts particular attention of neuroscientists as one of vesicular glutamate transporters (VGLUT2). In the rat brain, expression of VGLUT2 gene has been found in hypothalamic neurohypophysial neuroendocrine nuclei. This gene is also expressed in the pineal gland and the expression level depends on the environmental light condition. Glutamate in the gland is reported to regulate melatonin secretion in an autocrine fashion. Taken altogether, it is possible that intrinsic glutamate in the neurohypophysial neuroendocrine neurons regulates the hormone release at their terminal level, as supported by the presence of glutamate and NMDA receptors in the neuroendocrine terminals. The aim of this study is to explore experimentally the glutamatergic self-regulation of the hormone release by examining a correlation between vasopressin secretion and VGLUT2 expression. To this end, we evaluated expression levels of VGLUT2 gene in rats, which were dehydrated by water-deprivation or salt-loaded by drinking hypertonic saline, with in situ hybridization followed by BAS5000 and NIH image analyses. Under the normal condition, the gene expression was demonstrated in the paraventricular nucleus (PVN), supraoptic nucleus (SON) and lateral hypothalamic area. The BAS analysis on the dehydrated rats revealed that expression levels of VGLUT2 gene are specifically increased in the PVN and SON, and this was confirmed by NIH image analysis. However, no subregional difference within the PVN was observed in any dehydrated rats. In the salt-loading experiment, an increase of the gene expression levels was verified in both the PVN and SON. In contrast to the dehydrated rats, however, the increase of gene expression in the PVN was detectable only in the dorsal part of posterior magnocellular subdivision, a vasopressinergic neuron-dominant subregion. This study demonstrates that vasopressinergic neurons contain VGLUT2 whose gene expression is dynamically altered depending on the internal osmotic condition, suggesting an involvement of VGLUT2 in the self-regulation of vasopressin release by neurohypophysial glutamate.