L-Glutamate and L-aspartate concentrations in the developing and aging human putamen tissue

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Summary. We have previously reported that the developmental regulation of NMDA receptor expression in human brain is characterized by a sharp postnatal increase peaking at about age 1 year. We have now extended this work by measuring concentrations of L-glutamate and L-aspartate in the putamen from 45 human autopsy specimens. Both amino acids increased steeply within the first postnatal year after which they remained fairly constant throughout life. There was no impact on glutamate and aspartate levels in putamen of sex, side of the brain, postmortem time and storage time of brain tissue.

Keywords: Aspartate, glutamate, postmortem, human brain, putamen, ontogenesis, aging.

Introduction

In recent binding studies on postmortem human brain tissue we have characterized the developmental regulation of the N-methyl-D-aspartate (NMDA) receptor (Kornhuber et al., 1988a, 1989), a member of the excitatory amino acid transmitter receptor family. Receptor-specific binding displayed a postnatal increase reaching a maximum at about 1 or 2 years of age and showing a moderate decline with aging (Kornhuber et al., 1988a, 1989). We supplement this data now by reporting concentrations of endogenous excitatory amino acid receptor ligands, L-aspartate and L-glutamate.

Material and methods

Postmortem handling of the autopsy material was similar in all cases. Putamen tissue was obtained from either side at autopsy from 28 male and 17 female subjects without apparent history of neurological or psychiatric disorders (see Table 1 for more details). Tissue samples were stored at −80°C until neurochemical analysis.

Homogenates were prepared at +2°C and deproteinized by perchloric acid (Gottfried
Table 1. Case data

| Male/female | 28/17 |
| Age (yrs)   | 39.4 ± 28.9 (0.13–84) |
| Left/right  | 20/17 |
| Death to freezing interval (h) | 44.1 ± 21.8 (6–90) |
| Storage time at −80°C temperature (days) | 403 ± 218 (47–933) |

Mean values are given ± S.D. (Range), n = 45. Data regarding side of the brain were not available for all cases.

and Erdman, 1951). Amino acids were measured in the supernatant by C18-reversed phase high performance liquid chromatography as previously described (Kornhuber et al., 1988b). In brief, separation was performed after precolumn derivatization with ortho-phthaldialdehyde using a 150 * 4 mm column packed with Shandon ODS Hypersil, 3 μm (Grom, FRG).

Mean values are given ± SD. As several aspects of human brain maturation like synapse formation or neurotransmitter receptor expression behave differently before and after the second postnatal year (Huttenlocher and de Courten, 1987; Kornhuber et al., 1988a, 1989), correlation analysis was performed separately in the age group up to 2 years and that above 2 years. The statistical tests (t-test, Pearson’s correlation analysis) were used with the two-tailed approach. P-values higher than 0.05 were regarded as not significant.

Results

Both acidic amino acids increased steeply within the first postnatal year to reach a maximum at about age 1 year (Fig. 1). This increase reached statistical significance only in the case of aspartate (r = 0.65; p < 0.05). With aging no clear-cut deviation from constancy was observed. However, it cannot be excluded that minor alterations with age have been masked by the scatter. In the whole sample, no significant relation existed between the investigated amino acids and sex, side on the brain, storage period of brain tissue (data not shown) or death to freezing interval (Fig. 2).

Discussion

In general, there was good agreement between the concentrations of L-aspartate and L-glutamate given in this study and those of previous investigations reporting on free amino acids in the human brain (Perry et al., 1981; Perry, 1982; Lavoie et al., 1987).

To the best of our knowledge, we present for the first time the pattern of the postnatal alterations of L-glutamate and L-aspartate in human brain tissue. Both amino acids exhibited a sharp postnatal increase peaking at about age 1 year with fairly constant values thereafter. Two previously published studies are in agreement with the data presented here. Perry (1982) has measured L-glutamate and L-aspartate levels in postmortem human brain tissue. He divided