C H A P T E R IV

SUMMARY

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Although the chemical composition of the brain has been considered to be relatively stable, the high rate of turnover of brain proteins and the high incorporation of labelled glucose into glutamic acid in the brain suggest the active metabolic character of this organ. Protein deficiency has been found to result in histological changes in the brain of piglets.

Previous studies in this laboratory showed a decrease in the activities of certain cerebral enzymes and an impairment of psychological performance in rats subjected to a low protein diet.

The brain is far from a homogeneous bowl of porridge and has several anatomically and functionally distinct regions. Studies were therefore made of the effects of protein deficiency on chemical composition and metabolic activity in different regions of the brain. The regions studied were: cerebellum, medulla, pons, midbrain, olfactory lobes, visual cortex, basal ganglia, hypothalamus, corpus callosum and residual brain.

The parameters measured were:

I. weight and moisture content

II. protein content

III. activities of the enzymes namely, glutamate dehydrogenase, glutamate decarboxylase, alanine aminotransferase, aspartate aminotransferase, glutamyl transferase and glutamine synthetase

IV. oxygen consumption with glucose and glutamate as substrate

V. glutathione and ascorbic acid.

The weight of the whole brain and of different regions in the brain decreased by about 10% with protein deficiency. The basal ganglia, olfactory lobes and visual cortex however showed a greater reduction in weight.

Moisture content was slightly but consistently increased in all the regions by protein deficiency.

Protein content was decreased with the deficiency but the decrease was statistically significant only in the case of the cerebellum, pons and brain containing the thalamic region. In both groups relatively high concentrations of protein were found in the residual

brain, hypothalamus and olfactory lobes whereas low concentrations were found in the medulla, pons and hippocampus. The basal ganglia and the corpus callosum showed respectively high and low values in the LP group, and the reverse, in the HP group.

The activity of glutamate dehydrogenase was found to be high in the case of medulla, pons and midbrain and low in the case of the corpus callosum, hippocampus and cerebellum. The activity of this enzyme was found to be affected by deficiency in the corpus callosum, cerebellum, olfactory lobes, midbrain and the thalamic region. The pons, basal ganglia and visual cortex were not affected. The remaining regions showed some decrease, but this was not statistically significant.

The highest concentration of glutamate decarboxylase was found in the hypothalamus and midbrain, and the lowest concentrations, in the corpus callosum and pons. All the regions except the olfactory lobes and hippocampus were affected by deficiency. The LP values for the hypothalamus and basal ganglia were only about half the HP values with no overlap between the values for the two groups. The values for the medulla, visual cortex and the residual brain containing the thalamus were also markedly affected.

Alanine aminotransferase was found to be more in the visual cortex, midbrain, olfactory lobes and cerebellum and low in the hypothalamus and corpus callosum. Activity in almost all the regions was decreased by deficiency. The decrease was statistically significant in the case of the cerebellum, medulla, pons, olfactory lobes, visual cortex and residual brain and were most marked in the medulla and the pons.

The activity of aspartate aminotransferase was found to be more in the basal ganglia and less in medulla. All the regions were affected by protein deficiency.

The lowest values for glutamyl transferase were found in the corpus callosum, hypothalamus and basal ganglia whereas the highest concentration was found in olfactory lobes. The visual cortex, cerebellum, pons and midbrain also had relatively higher concentrations. The regions affected by protein deficiency were pons, visual cortex, basal ganglia and residual brain. A difference was also found in the case of the hypothalamus but this was not statistically significant although numerically large because of the small number of observations.

The activity of glutamine synthetase was low in the corpus callosum and the basal ganglia whereas it was high in the cerebellum, olfactory lobes and visual cortex. The values for the LP group (8-19) tended to be somewhat less than those for the HP group (9-19) but the differences were significant only in the case of basal ganglia and medulla.

In studies carried out on the effects of protein deficiency on different regions of the brain the oxygen consumption of brain tissue slices was also found to be influenced. In many brain regions oxygen uptake by tissue slices was found to be less in the LP animals when glucose was used as a substrate. This difference was either decreased or reversed with the use of glutamate as substrate. The same phenomenon was evident to some extent when homegenates were used in place of slices.

The studies on ascorbic acid distribution confirmed previous observations of a decrease in brain ascorbic acid with protein deficiency. There was no overlap between the values for the two groups except in the case of the basal ganglia. The regions most affected were the hypothalamus, pons, visual cortex and hippocampus.

The concentration of glutathione was found to be decreased with protein deficiency in all the regions. But the differences were not statistically significant in the case of some regions, namely, the midbrain, the basal ganglia and the corpus callosum. The values of ascorbic acid in different regions were found to be significantly correlated with those of glutathione.

To summarize the different regions of the brain showed variations in chemical composition and metabolic activity. They also differed in their susceptibility to the effects of protein deficiency. Activities of several enzymes were found to be low in the corpus callosum and high in the case of the visual cortex and olfactory lobes. To the latter group may be added the cerebellum, the hypothalamus and the portion of the brain containing the thalamic region. The interesting observation ~~was~~ made, that the pons, medulla and midbrain showed high activity of glutamate dehydrogenase, glutamate decarboxylase and alanine aminotransferase, although they generally showed low values in the case of other parameters. This was strikingly evident in the case of glutamate dehydrogenase.

The extent of variation between different brain regions varied with the parameter measured. For instance, the protein content of different regions did not vary by more than 25%. In contrast the variation was more in the case of glutamate decarboxylase (400%), alanine aminotransferase (200%) and ascorbic acid (100%). The other parameters measured showed intermediate degrees of variation.

The effects of protein deficiency were generally less evident in the case of certain regions, for example, the olfactory lobes, and more evident in the case of other regions such as the cerebellum and medulla.