EFFECT OF THE PINEAL BODY ON REGULATION OF PROTEIN METABOLISM

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Definite intensification of incorporation of methionine-S^{35} into protein and an increase in the protein content in the liver were found 14 days after pinealectomy. Activation of protein metabolism in pinealectomized animals can be explained by removal of the inhibitory influence of the pineal body on the gonadotropic and somatotropic functions of the adenohypophysis.

Interest in the study of the pineal body has recently increased, in particular, with the appearance of descriptions of new investigations into its role in the body [1, 4-13, 15]. However, the results so far as interaction between the pineal body and endocrine glands and its effect on various types of metabolism are concerned are largely contradictory.

On the basis of the available information it seems that there is a predominantly antagonistic interaction between the pineal body and pituitary hormones: thyrotropic hormone [11], ACTH [9], and gonadotropic hormones [1, 10, 15].

The effect of the pineal body on carbohydrate and protein metabolism is considered to be mediated through pituitary hormones. Pineal extract induces hypoglycemia and increases the liver glycogen content [7], while according to other observations, it raises the blood sugar [13]. Pineal extracts are known [12] to delay longitudinal growth of the long bones. On the other hand, pineal extract is known to increase the RNA and DNA contents in the liver and to stimulate protein synthesis [8].

Because of the contradictory nature of the experimental evidence on the effect of the pineal body on protein metabolism, it was decided to undertake the present investigation.

EXPERIMENTAL METHOD

Female rats weighing 140-220 g were used. The pineal body was removed from the rats of group 1, a mock operation was performed on the rats of group 2, while the animals of group 3 remained intact (control). The rats were decapitated on the 14th-15th day and the liver and gonads of the experimental animals were weighed.

To assess the state of metabolism in the liver the following indices were used: the coefficient of proteolysis, calculated from the ratio between nonprotein and protein nitrogen, the coefficient of urea formation, calculated from the ratio between the urea nitrogen and the nonprotein nitrogen of the liver. Total and nonprotein nitrogen were determined by Folin's method [3], the urea content in the liver tissue by the phenylhypochlorite reaction in the writers' modifications [2], and changes in the total content of the amino-acids in the liver tissue by the method of Pope and Stevens [14]. In addition, the percentage incorporation of methionine-S^{35} into proteins was determined in the liver, kidneys, and muscles of the experimental animals and the relative activity of protein was calculated by the formula:

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$$\frac{\text{Activity of protein in 1 g tissue (pulses/min)}}{\text{Activity of 1 g tissue (pulses/min)}}.$$

Methionine-S^{35} was injected intraperitoneally in a dose of 10,000 pulses/min/g body weight.

EXPERIMENTAL RESULTS AND DISCUSSION

The results showed a significant increase in the protein content in the liver of the pinealectomized rats compared with those undergoing the mock operation and the intact animals. The content of protein nitrogen in the liver rose on the average from 2.64 to 2.9 g%, with a corresponding increase in the protein content in the liver from 16.5 to 18.3 g% ($P < 0.001$) with no significant changes affecting the indices of protein metabolism (nitrogen of amino acids and urea). The coefficient of proteolysis and the coefficient of urea formation in the liver likewise were unchanged: the coefficient of proteolysis in the pinealectomized rats was 11.33% compared with a normal value of 10.81%, while the coefficient of urea formation was 12.97% compared with a normal level of 12.07% ($P > 0.5$).

It can be concluded from these results that removal of the pineal body in rats does not cause significant changes in protein metabolism in the liver, but that the increase in the protein content in the liver is associated with some increase in the intensity of protein synthesis. To shed light on this problem, experiments were carried out to determine the intensity of incorporation of methionine-S^{35} into proteins of the liver, kidneys, and muscles of pinealectomized rats compared with normal controls (Table 1). This increase was most marked in the liver where, together with an increase in the percentage of incorporation of methionine-S^{35}, the relative activity of protein also was increased – from 0.35 to 0.56 ($P < 0.001$). Consequently, the increased protein content in the liver of the rats after pinealectomy was associated with definite stimulation of protein synthesis. This phenomenon was evidently connected with an increase in the function of the gonads of the rats after pinealectomy.

The weight of the gonads of the pinealectomized rats was increased compared with the intact animals on the average from 2.65 to 3.25 g ($P < 0.001$). The increase in weight of the gonads of the pinealectomized animals can be attributed to absence of the inhibitory influence of the pineal body on secretion of gonadotropic hormones by the pituitary. The action of the pineal body through the hypothalamus is evidently mediated by blocking of the secretion of hypothalamic neurohormones. In the absence of the pineal body this blocking is abolished and the secretion of pituitary gonadotropic hormones is increased. It may be that both mechanisms – indirectly through the hypothalamus and the direct action of pineal hormones on the pituitary – possibly participate in the mechanism of action of the pineal body on the secretion of pituitary gonadotropins.

Consequently, pinealectomy leads to an increase in function of the adenohypophysis through abolition of the inhibitory effect of the pineal. This is shown by the increase in weight of the gonads of the pinealectomized animals compared with the controls and the definite stimulation of protein metabolism in the rats after pinealectomy. This intensification was accompanied by an increase in the incorporation of methionine-S^{35} into the proteins of the liver, kidneys, and muscles, with an increase in the protein content in the liver ($P < 0.001$). This effect in the pinealectomized animals is evidently associated with an increase in the

TABLE 1. Changes in Relative Activity of Protein and Percentage Incorporation of Methionine-S^{35} into Proteins of Liver, Kidneys, and Muscles of Rats After Pinealectomy (Mean Results of 15 Experiments; M ± m)

Nature of Procedure	Mean weight of rats (in g)	Liver		Kidneys		Muscles	
		percent incorp. of methionine-S^{35}	rel. activity of protein	percent incorp. of methionine-S^{35}	rel. activity of protein	percent incorp. of methionine-S^{35}	rel. activity of protein
Mock operation (control)	190	6,4±0,9	0,35±0,01	16,2±2,3	0,40±0,02	2,5±0,3	0,28±0,01
Pinealectomy	195	9,3±1,1	0,56±0,02	18,1±1,9	0,43±0,02	3,2±0,4	0,33±0,01
P		<0,05	<0,01	>0,5	>0,5	>0,05	<0,05

secretion of gonadotropic hormones, which exert an anabolic action on protein metabolism. The possibility cannot be ruled out that the increased intensity of protein metabolism after pinealectomy may be connected with increased secretion of pituitary growth hormone.

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