CORRELATION BETWEEN FUNCTIONAL ACTIVITY OF THE ADRENALS AND GONADS OF PUBERTAL MONKEYS

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Mechanisms of functional interaction between adrenals and sex glands at different stages of development have attracted the attention of investigators for a long time. Interaction between the above-mentioned glands in critical periods of development and, in particular, in the period of puberty, has aroused particular interest [5]. This is due to the fact that deviations in the normal development of the adrenal glands may lead to disturbance of the hormonal mechanisms of sexual maturation [8].

Most publications in the world literature on the problem of sexual maturation have been devoted to the study of function of the sex glands and the higher structures regulating their activity. Data in the literature on the study of the endocrine function of the adrenal cortex during the pubertal period are much less abundant and are often contradictory in character [1, 3, 4, 6, 7].

Existing contradictions are probably due mainly to the two following causes. First, the use of different experimental animals, differing greatly in their endocrine parameters and the mechanisms of sexual maturation, as the model. Second, the use of cross-sectional study to analyze the time course of sex hormone and corticosteroid levels during the pubertal period. This approach can cancel out existing changes as a result of marked individual variability in hormone concentrations, characteristic of the pubertal period.

For the reasons given above, we undertook the parallel study of function of the sex glands and adrenals of baboons (*Papio hamadryas*) during the pubertal period in the course of 1 year by means of longitudinal study.

EXPERIMENTAL METHOD

Six prepubertal male baboons aged 3 years were used. During the experiment the baboons were kept as a group in one large cage without adult animals. Blood was taken once every 2 weeks for 1 year for determination of sex hormones and corticosteroids.

Concentrations of hormones and their precursors (testosterone and 5α-dihydrotestosterone, cortisol, 17-hydroxyprogesterone, 17-hydroxypregnenolone, dehydroepiandrosterone, progesterone, aldosterone) were determined by radioimmunoas say preceded by chromatographic separation of individual compounds on columns with celite.

The plasma was kept until required for radioimmunoassay in the frozen state at −20°C.

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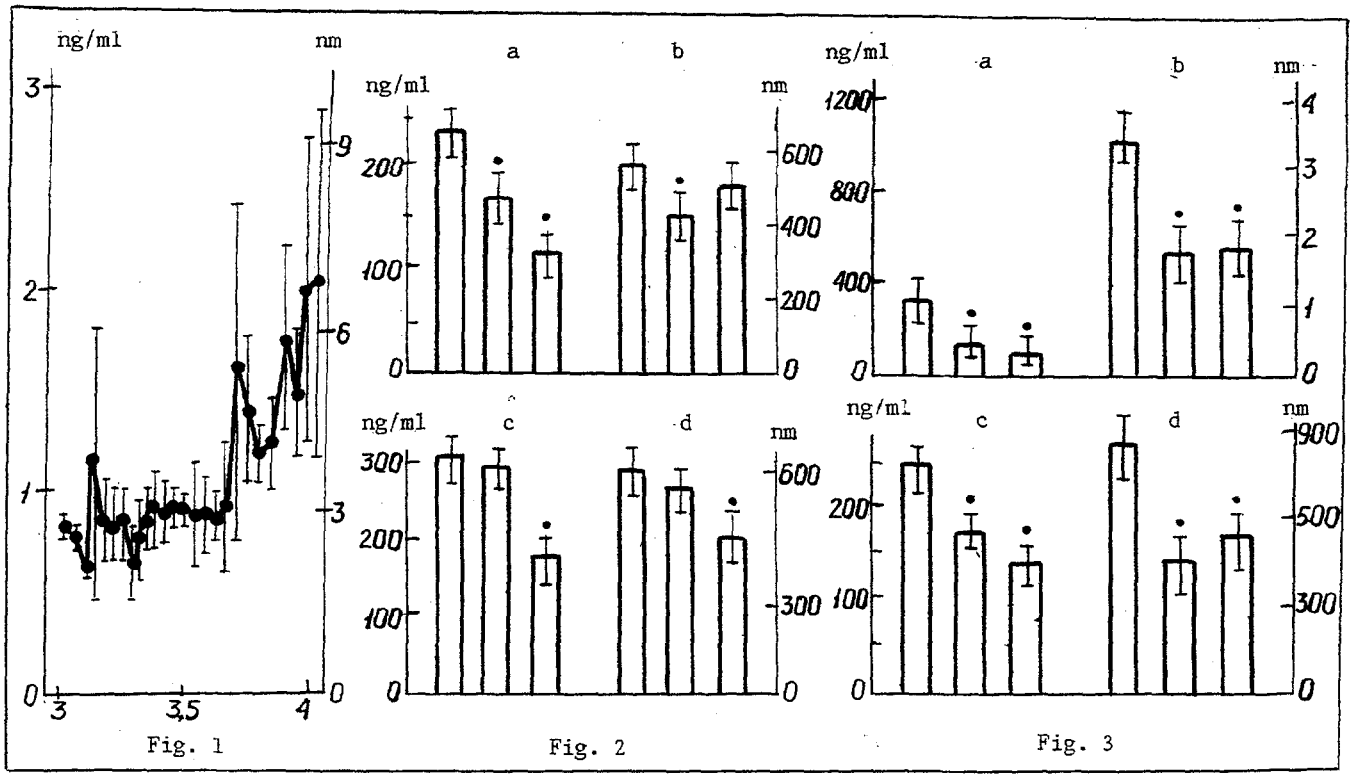

Fig. 1 Fig. 2 Fig. 3

Fig. 1. Trend of total blood testosterone and dihydrotesterone levels in pubertal male baboons during the 4th year of life. Abscissa, age of animals (in years); ordinate, concentration of androgens (in ng/ml and nM). Data for six animals are shown.

Fig. 2. Individual trends of blood cortisol levels of four pubertal male baboons (A, B, C, D) in consecutive quarters of the 4th year of life. Each column on the graph represents the arithmetic mean (M ± m) blood cortisol concentration of a single animal during one quarter of the year during which blood was taken for hormone assay eight times (once every 2 weeks). Data for which $p < 0.05$ indicated by an asterisk.

Fig. 3. Individual trends of 17-hydroxyprogesterone (top part of figure, A and B) and progesterone (bottom part, C and D) blood levels of two pubertal male baboons in consecutive quarters of the 4th year of life. Legend as to Fig. 2.

EXPERIMENTAL RESULTS

The initial content of androgens, namely the total blood testosterone and dihydrotestosterone, of the experimental monkeys at the age of 3 years was below 3.5 nM and no marked individual variations were found (Fig. 1). During the 4th year of life the androgen content was more than doubled, to reach 7.6 nM. Between the ages of 3.5 and 4 years there were marked individual differences in the total blood androgen level of the experimental animals.

Strong positive correlation ($r = 0.82$) was found between the testosterone and dihydrotestosterone blood levels of the monkeys in the 4th year of life.

Individual trends of the blood cortisol level of four animals (A, B, C, D: Nos. 16418, 17252, 16749, and 16766 respectively) during consecutive quarters of the 4th year of life are illustrated in Fig. 2. The initial cortisol level varied on average from 550 to 830 nM. In the 2nd and 3rd quarters a significant fall of the blood cortisol level was observed in each of the four monkeys.

Analysis of individual trends of steroid concentrations showed that the greatest decrease in the blood cortisol concentration of the monkeys in the pubertal period was observed in animals with the greatest increase in rise of the testosterone level. For example, the testosterone level in one of the experimental animals (No. 16418) rose 7.5-fold

during the 4th year of life (from 2.8 to 21 nM), whereas the cortisol concentration fell at the same time by 2.9 times (from 965 to 328 nM).

Concentrations of the other precursors fell significantly in the same male during consecutive quarters of the 4th year of life: 17-hydroxypregnenolone and dehydroepiandrosterone by 5.2 and 2.0 times respectively.

Individual trends of 17-hydroxyprogesterone (A, B) and progesterone (C, D) in the blood of two experimental animals (Nos. 16418 and 17252), in which a maximal increase of the blood testosterone concentration was observed during the 4th year of life, are shown similarly in Fig. 3. During the second and third quarters of this period the concentration of these steroids was significantly lower than during the first quarter.

During the 4th year of life the aldosterone concentration did not change significantly, and averaged from 2022 ± 172 to 2052 ± 197 pM in different quarters of this period.

A parallel study of the endocrine function of the sex and adrenal glands was thus undertaken in a group of monkeys (*Papio hamadryas*, males) in the pubertal period in the course of 1 year. Besides elevation of the androgen levels in the experimental animals, a significant decrease was observed in concentrations of corticosteroids and their precursors: cortisol, progesterone, 17-hydroxyprogesterone, and 17-hydroxypregnenolone, and also of the adrenal androgen – dehydroepiandrosterone.

The mechanism of the decrease in the corticosteroid levels during sexual maturation has been studied in guinea pigs [6]. The authors cited link this phenomenon with at least two circumstances. First, with weakening of 11β-hydroxylase activity during sexual maturation of the guinea pigs. Second, with an increase in Δ^4-hydrogenase activity during the pubertal period.

However, in the present experiments, changes in 11β-hydroxylase activity can account only for the fall of the cortisol level, and not of that of its precursors, which do not contain a hydroxyl group attached to the carbon atom in position 11 in their structure.

An increase in Δ^4-hydrogenase activity can explain the decrease in the blood cortisol corticosterone concentrations in the pubertal experimental animals, but these changes are more likely to be connected with metabolic differences than differences in steroid biosynthesis.

Besides the causes mentioned above, in our view a deficiency of enzyme systems (20- and 22-hydroxylases, and also 20-22C-liase) at the stage of conversion of cholesterol into pregnenolone likewise cannot be ruled out. This process, as we know, is the limiting stage in the synthesis of all steroid hormones, both in the adrenal cortex and in the sex glands [2].

The importance of the phenomenon we have discovered, namely a fall of the blood corticosterone levels in pubertal animals, must be regarded in the context of the role of the adrenal cortex in the realization of adaptive reactions of the animal. In the growing organism relations between the endocrine glands are highly labile, and the functional reserves of the endocrine structures are relatively low [1]. Accordingly, the fall of the blood cortisol level in the pubertal period may be a predisposing factor relative to significant disturbances affecting individual systems of the body.

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