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Short note

EFFECTS OF EXPERIMENTALLY IRRADIATED PITUITARY GLAND ON SOME MORPHOLOGICAL PARAMETERS OF RATS' HEAD, BODY AND TIBIA*

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Abstract. *Studies of X-rays irradiation effects on biological systems are still meaningful and actual. The aim of present work was to examine the effects of pituitary gland irradiation on rats' growth and development, and the impact of pituitary gland protection during cranial irradiation. During the experiment, rats were divided into three groups. Animals in the first group (control group) were not irradiated. In the second and third groups animals received cranial irradiation with 240 kV X-rays at doses of 27.92 Gy (n=10 per group), applied during 8 sessions, in the period from 8 to 63 days of age. In the second group, rats had the pituitary gland protection in the form of a lead plate set below the projection of the pituitary. Animals in the third group were irradiated without the lead plate protection of the pituitary gland. In second group with protected pituitary gland, no significantly harmful effects of radiation were observed in animals. After the cranial irradiation without pituitary gland protection (third group), animals showed significant retardation of physical growth which was manifested in the reduction of pituitary gland mass as in the body and tibial mass and length.*

Key words: *Cranial irradiation, rat, pituitary gland, physical grow*

1. INTRODUCTION

Hypophysis is endocrine gland which hormones directly or indirectly affect the functioning of the organism from birth, through growth and development, physical, sexual and mental function until death. In animals hypophysis is consist from parts with different origins and functions. Adenohypophysis (anterior lobe) produces: growth (somatotropic) hormone (STH), gonadotropic hormones— follicle-stimulating (FSH) and luteinizing (LH), adrenocorticotropic hormone (ACTH), thyroid-stimulating hormone (TSH) and prolactin. The intermediate part produces α-melanocyte-stimulating hormone (MSH). The production of all these is controlled by regulating, hypophysiotropic hormones and releasing or inhibitory factors such as gonadotropin-releasing hormone (GnRH), somatostatin (SS), growth hormone- releasing hormone (GRH), and corticotropin-releasing hormone (CRH), to name the most important. The hormones stored and later released into the circulation by the neurohypophysis are oxytocin and vasopressin [1].

Cranial irradiation has been used in therapy of carcinoma in head and neck area. The consequences can be the hypofunction of the pituitary gland. The endocrine deficits in humans can range from mild isolated growth hormone (GH) deficiency to severe pan-hypopituitarism, though GH is commonly the first anterior pituitary hormone to be affected [2]. In rats' radiation lead to reduction of pituitary and body weight and compromised growth between 8 and 20 weeks [3]. Growth hormone (GH) and prolactin (PRL) were most sensitive and decreased by more than 90% after irradiation, while thyroid stimulating hormone (TSH) contents were reduced at 14 and 20 weeks after irradiation.

Due to increasing application of ionizing radiation in human and veterinary medicine in diagnosis and therapy, investigations of radiation effects are important. The aim of present work was to examine the effects of pituitary gland irradiation on rats' growth and development, and the impact of pituitary gland protection during cranial irradiation.

2. MATERIALS AND METHODS

2.1. Irradiation

The experiments were performed on thirty male and female Wistar rats, divided into three groups, with ten rats per group (n=10 per group). First group (I group) was control group, where rats did not irradiate. In second and third groups animals were irradiated

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with 240 kV X-rays at doses of 27.92 Gy applied during 8 sessions, in the period from 8th to 63rd days. In the second group (II group) rats had the pituitary gland protection in the form of lead plate set below the projection of the pituitary (protected group). Animals in the third group were irradiated without the lead plate protection of pituitary gland (irradiated group). The remainder of the body was shielded by lead in both groups.

Animals head were irradiated with "Phillips" X-ray machine, which is used in radiotherapy, under the following conditions: 240 kV; 7.5 mA; 10 mm Al filter; dose rate 18.321 cGy/min, time 19 min and 2 second and the skin-focus distance (KFD) 87.5 cm. The total radiation dose of 27.92 Gy was divided into 8 individual doses of 3.49 Gy. Irradiation was performed twice a week (Friday-Tuesday), every other week. First irradiation was at 8-th days of age, and then on 12, 22, 26, 36, 40, 50 and 54 day. Animals were sacrificed on 63 day of experiment. All experimental procedures were performed in accordance with the European Council Directive (86/609/EEC).

2.2. Measurement of body weight and length

The animal's growths were determined by measuring the body length and weight on 8, 16, 22, 29, 36, 43, 50, 56 and 63 days. Length was measured with a ruler and weight was measured on sensitive "OHAUS" scales for laboratory animals. When in the same days animals were irradiated and measured, irradiation was first performed. After animals decapitation pituitary glands and tibia excised and weight.

3. RESULTS AND DISCUSSION

In rats period of growth and develop ends at about 60 days of age, when they reaches sexual maturity, and then slightly slowed down, and continues until 90 days. After that period increase of body weight is a result of obesity. If some external factors from environment affecting the growth, the best time to study these effects is the first 60 days after birth. The irradiation effects in both groups were monitored by measuring the pituitary mass (Table 1), body and tibial weight and length (Fig 1, Fig 2, Fig 3, Fig 4). In the protected group (second group) average mass of the pituitary gland was slightly lower than the control group and there is no doubt that a lead plate thickness of 6 mm prevents the X-ray penetration (Table 1). The difference in pituitary mass may be explained by the effect of secondary radiation, originated from the skull bones. This assumption of bones as a secondary source of radiation was presented by Nwoku and Koch [4] in the study of the impact of radiation therapy on the jaw and teeth in children's with nasopharyngeal carcinoma.

Table 1. Pituitary gland mass (mg)

Group	Mass
Control group	7.5 ± 0.4
Protected group (Group 2)	7.2 ± 0.2
Irradiated group (Group 3)	4.2 ± 0.3***

arithmetic mean ± standard deviation
*** statistically highly significant ($p<0.001$)

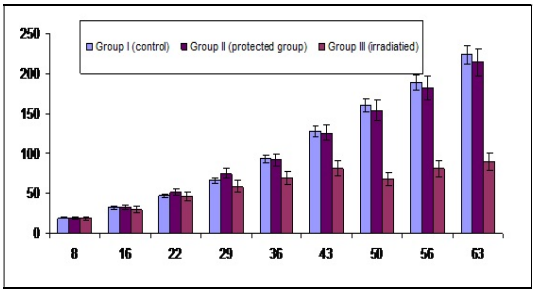

Figure 1. Body mass (g) during the period from 8th to 63rd day of experiment

Rats in the control group had a uniform growth and constant increase of body mass which was most intensive between the 29th an 50th day (Fig. 1). Similar results were observed in the protected group (second group) until 16th day. In the period from 22nd to 29th day of experiment, significantly higher increase of body mass were observed compared to the control group which can be explained by the stimulating effect of radiation and preserved pituitary gland function. After this period the body mass decreases were not statistically significant. Body length in protected group increasing constantly but were non uniform. At the end of experiment small differences in the length of the rats in this group, compared to the control group, were observed. This can be attributed to the effect of radiation on the jaw and teeth and consequential difficulty of food consumption. The differences in body length between control and protected group were not statistically significant.

After the cranial irradiation without protection (third group) pituitary gland mass was dramatically less than in control and protected groups (second group), which is result of the direct effects of X-rays to this gland (Table 1). In this group, compared with control and protected groups, statistically high significant decrease of body mass and length were observed starting from 29th of experiment. The higher decrease of body mass was recorded on 50th day, when the animals' body weight was less than in rats at 36th days of life. This is due to depletion of body reserves in period when they reach puberty and have a tendency to intensive growth, and insufficient growth hormone synthesis due to the radiation damage of the pituitary gland. The body weight decrease after rats' irradiation was confirmed by other authors [3], [5]-[9] as a consequence of pituitary gland damage, decrease of pituitary hormones contents [3], as well as the pathological changes in the mouth [7]-[8].

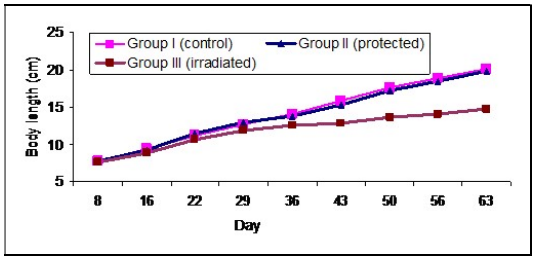

Figure 2. Body length (cm) during the period from 8th to 63rd day of experiment

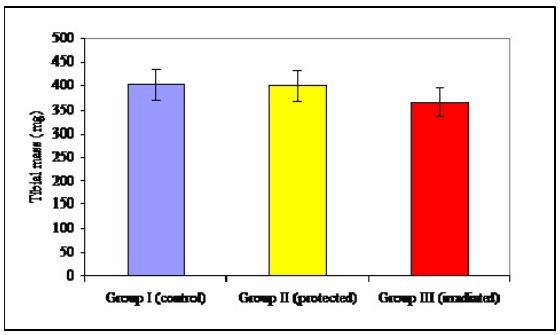

Figure 3. Tibial mass (mg)

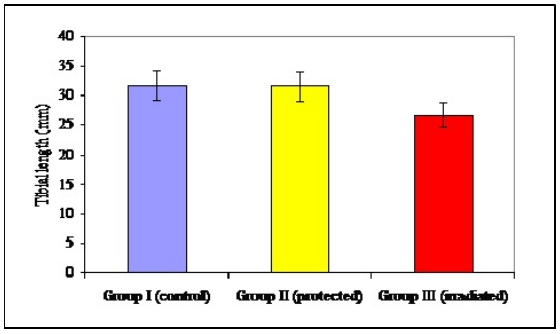

Figure 4. Tibial length (mg)

4. Conclusion

Local irradiation of rats' head, from early period of life to sexual maturity, with total dose of 27.92 Gy divided into 8 sessions, causes a retardation of physical growth which were manifested in the reduction of pituitary mass, as well as body and tibial mass and length. The use of pituitary gland protection during cranial irradiation significant reduced harmful radiation effects to this gland.

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