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Characteristics of Anatomical Parameters of Rat Testes in Normal Conditions and Under Irradiation in the Age Aspect

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ABSTRACT

The aim is to study the anatomical parameters of the testes of rats in normal conditions and under irradiation in postnatal ontogenesis.

Materials and methods. The study used 124 white outbred rats in newborns, 3, 6, 9, 12 months of age. The animals were divided into 2 groups: control and experimental. The rats of the experimental group were irradiated for 20 days with a total dose of 4 Gy of ionizing radiation.

Results. The morphometry of the testes showed that their weight, length, and thickness in postnatal ontogeny vary unevenly. Comparison of the rate of increase in body weight and length with the weight and volume of the testes shows that with an increase in their volume, body weight increases more than length.

Conclusions. It was found that in the experimental group, the parameters of physical development lag behind intact animals. The lag is more pronounced in the 6-month period.

KEYWORDS: *irradiation, anatomical parameters, testes, morphometry*

The urgency of the problem

Exposure to ionizing radiation (IR) is becoming increasingly common in medicine for the diagnosis of diseases and the treatment of cancer. In addition to patients undergoing treatment, infrared radiation also poses a great danger to healthcare professionals. Most medical examinations require X-rays to diagnose the disease and then treat them. But even in cases with cancer patients, treatment may also require radiation therapy, which is already radiation for the patient [3]. Although all living things are at risk of injury in response to ionizing radiation, the testes of mammals are much more sensitive to them [6].

The testes are key organs involved in maintaining male fertility through testosterone synthesis and male gamete production [7]. In addition, spermatogenesis in the testes occurs due to the differentiation of germ cells at different stages of development. The toxic effects of IR interfere with normal spermatogenesis, affecting the proliferation and differentiation of spermatogenic cells, which ultimately leads to cellular mutagenesis or apoptosis and leads to a decrease in the number and impaired production of spermatozoa [1,4,8].

Radiation sources are divided into natural and artificial sources. Natural sources include gamma rays from the decay products of uranium, decay products of gaseous radon in the atmosphere, natural radionuclides and cosmic rays from space. Sources of man-made radiation include radionuclides found in food and drink, X-rays used in medical diagnostic procedures, and gamma rays generated as by-products in the nuclear industry and products generated during nuclear tests in the atmosphere.

Radiation exposure has early and late effects on the exposed organism [5]. It is fraught with the occurrence of local changes - radiation burns, necrosis, cataracts and general phenomena - acute and chronic radiation sickness, as well as long-term consequences - malignant neoplasms, hemoblastosis, hereditary pathology, reproductive disorders, functions of the neuro-endocrine, immune and other systems, decreased adaptive capacity, premature aging, decreased average life expectancy. Although many studies have been carried out to study the effect of radiation on the reproductive organs, there is not enough information on the changes in the structures of these organs in the age aspect in postnatal ontogenesis. [2,8].

The aim of the study

Was to study the anatomical parameters of the testes of rats in normal conditions and under irradiation in postnatal ontogenesis.

Materials and methods

An experimental study was carried out on material taken from the testes of 124 white nonlinear rats from the moment of birth to 12 months of age, which were kept in a vivarium under a 12-hour light regime, with a standard diet and free access to water. At the beginning of the experiment, all sexually mature rats were in quarantine for a week, and after excluding somatic or infectious diseases, they were transferred to the usual vivarium regimen. The animals were divided into 2 groups (n = 124): I group - control (intact) (n = 69); II - group - rats that received irradiation for 20 days from 71 days of age at a dose of 0.2 Gy (the total dose was 4.0 Gy) (n = 55).

In the experimental group, irradiation of rats began at 71 days of age and lasted for 20 days in a fractional daily dose of 0.2 Gy (the total dose was 4.0 Gy) up to 90 days of age using the apparatus DTGT "AGAT R1" (plant "Baltiets" Narva, Estonia, 1991 release, operation since 1994, recharge 2007, capacity 25.006 cGy / min.).

The animals were slaughtered at the appropriate time in the morning on an empty stomach by means of instant decapitation under ether anesthesia. After opening the pelvis cavity, the testes were removed and their mass, length, width, volume and tissue density were examined. The weight of each of the testes was measured on an electric balance, and the length and width were measured with a millimeter tape. The volume of testes according to the formula:

V = 0.523 × n × c2,

where: n, c - respectively, the length and thickness of the testes 0.523 - constant coefficient.

The research materials were statistically processed using the methods of parametric and nonparametric analysis. The accumulation, correction, systematization of the initial information and the visualization of the results were carried out in Microsoft Office Excel 2010 spreadsheets. Statistical analysis was carried out using the IBM SPSS Statistics v.23 program (developed by IBM Corporation).

Research results and their discussion

In newborn rat pups, body weight ranges from 4.58 g to 5.86 g, on average 5.0 ± 0.0928 g. Body length (frontal-tail size) from 3.83 to 4.82 cm, on average 4.4 ± 0.0742 cm. The testes are located mainly in the abdominal cavity and in the inguinal-scrotal canal and have a rounded-oval shape. The weight of the testes ranges from 0.015 to 0.027 g, on average - 0.02 ± 0.0007 g. The length of the testes varies from 0.27 to 0.39 cm, on average 0.34 ± 0.078 cm, and its thickness ranges from 0, 17 to 0.26 cm, on average - 0.21 ± 0.0070 cm. The volume of testes is from 0.008 to 0.013 cm^3, on average - 0.01 ± 0.0004 cm^3.

The parameters of physical development and anatomical indicators of the testes of the rats of the control group in terms of age are given in table № 1.

Table № 1 The parameters of physical development and anatomical indicators of the testes of the rats of the control group

Age Day	Body mass, g	Body length, cm	Mass of testes, g	Length of testes, cm	Thickness of testes, cm	Volume of testes, cm^3
Newborns	5,0±0,0928	4,4±0,0742	0,02±0,0007	0,34±0,0078	0,21±0,0070	0,01±0,0004
90	106,8±1,229	14,8±0,189	0,78±0,017	1,42±0,035	0,91±0,025	0,76±0,013
180	218,3±1,021	17,6±0,280	1,20±0,023	2,18±0,020	1,36±0,006	2,57±0,015
270	255,7±1,541	19,8±0,374	1,26±0,032	2,29±0,013	1,43±0,023*	2,95±0,010
360	283,8±1,596	21,1±0,273*	1,32±0,015	2,40±0,018	1,50±0,024*	3,32±0,021

Note: * P <0.05; - reliability of differences in relation to the previous observation period

In 90-day-old rats that received irradiation, body weight ranges from 91.1 to 106.82 g, an average of 101.1 ± 0.954 g. The absolute increase is 96.1 g, the growth rate is 1922%.

The body length of rats ranges from 11.93 to 16.44 cm, on average 14.0 ± 0.273 cm, the absolute increase in body length is 9.6 cm, and the growth rate is 218.2%.

The testes are oval, located in the scrotum, sometimes rising into the inguinal-scrotal canal. The mass of testes in rats is 0.58-0.85 g (on average - 0.72 ± 0.015 g), the increase is 0.7 g (the growth rate is 3500%). The length of the testes is 1.09-1.57 cm (on average 1.34 ± 0.027 cm), an absolute increase of 1.0 cm (the growth rate is 294.1%). The thickness of the testes is 0.7 - 1.1 cm (on average - 0.84 ± 0.026 cm). The absolute growth was 0.63 cm, and the growth rate was 300.0%. The volume of the testes averages 0.62 ± 0.010 cm^3. The absolute growth was 0.61 cm^3, the growth rate was equal to 6100%. Against the background of a sharp increase in volume, the density of the testes tissue decreases.

In rats of 180 days of age, body weight ranges from 165.02 to 191.74 g, on average 179.1 ± 2.473 g, the absolute increase was 78.0 g. Body weight increases 1.8 times compared to the previous age (increase 77.2%). Body length 14.01-16.43 cm (average - 15.0 ± 0.221 cm). The growth was 1.0 cm, the growth rate was 7.1%. The mass of testes is in the range from 0.89 to 1.00 g, on average - 0.95 ± 0.009 g. The absolute increase was 0.23 g, the growth rate was 31.9%. The weight of the testes increased by 1.3 times compared with this indicator. The length of the testes ranges from 1.67 to 1.85 cm, on average 1.77 ± 0.016 cm, the absolute increase is 0.43 cm, the growth rate is 32.1%. The thickness, or transverse size of the testes varied from 1.05 to 1.16 cm, on average - 1.11 ± 0.010 cm, the absolute increase was 0.27 cm, and the growth rate was 32.1%. The average indicator of the volume of the testes separately is 1.43 ± 0.031 cm^3. The absolute increase in the volume of the testes was 0.81 cm^3. The volume of the testes increased by 2.3 times.

In 270-day-old male rats who received irradiation, body weight ranged from 212.56 to 227.05 g, on average - 219.8 ± 1.067 g, the absolute increase is 40.7 g, and the growth rate is 22.7% . The body length of rats ranges from 16.26 to 18.28 cm, on average 17.4 ± 0.198 cm. The absolute increase in body length at this age is 2.4 cm, the growth rate is 16.0%.

Testes of 270 - day old rats of this group have an oval shape, the weight of testes is from 0.96 to 1.15 g, on average - 1.06 ± 0.017 g, the absolute growth of testes in this group is 0.11 g, the growth rate is 11.6%. The length of the testes is 1.85-2.04 cm (on average - 1.96 ± 0.018 cm), the growth is 0.19 cm (the growth rate is 10.7%). The thickness of the testes is 1.19-1.29 cm (on average, 1.23 ± 0.009 cm). The absolute increase is 0.12 cm, the growth rate is 10.8%. The volume of the testes is 1.94 ± 0.030 cm^3, the growth rate is 0.51 cm^3 (the growth rate is 35.7%).

The body weight of male rats of 360 days of age ranged from 247.55 to 273.73 g, on average - 261.1 ± 2.161 g. The absolute increase in body weight in this group was 41.3 g, and the growth rate was 18.8 %. The body length of the rats varied from 18.39 to 20.99 cm, on average 19.5 ± 0.225 cm, the absolute increase was 2.1 cm, and the growth rate was 12.1%.

In male rats of this group, the weight of testes individually ranges from 1.03 to 1.31 g, on average 1.20 ± 0.023 g, the absolute increase was 0.14 g, and the growth rate is 13.2%. The length of the testes is from 2.14 to 2.26 cm, on average - 2.19 ± 0.011 cm, where the absolute increase is 0.23 cm, the growth rate is 11.7%. The thickness of the testes (transverse size) of the rats of this group ranged from 1.33 to 1.41 cm, on average - 1.37 ± 0.007 cm, the absolute increase was 0.14 cm, and the growth rate was 11.4%. The volume of testes is on average 2.69 ± 0.025

cm^3, the absolute increase is 0.75 cm^3, the growth rate is 38.7%.

In the control group, up to mature (360 days) age, body weight increases 56.7 times, and body length increases 4.8 times. The highest rate of weight gain is observed at 90 - (2036%) and 180 days (104.4%) age, the smallest - at 360 (11.0%) and 270 (17.1%) days of age. A high rate of increase in body length was also noted at 90 (236.4%) and 180 (18.9%) days of age, the smallest - at 360 (6.6%) and 270 (12.5%) days of development. In newborn rats, the weight of the testes is on average 0.02 ± 0.0007. Until adulthood (360 days of age), this indicator increases 66 times (1.32 ± 0.015). The length and thickness of the testes increase by 7.06 and 7.14 times, respectively, and the volume by 332 times. Until puberty, the lumen of the convoluted seminiferous tubules is closed and filled with spermatogenic epithelium and trophic intercellular substance. At puberty, the lumen of the convoluted seminiferous tubules opens for the advancement of sperm, so the density of the testis tissue decreases. Comparison of the rate of increase in the body weight of rats and the weight of the testes, up to sexual maturity, shows that in animals of the control group, the weight of the testes increases almost 1.16 times (66 times) faster than body weight (56.7 times)

In rats of the experimental group up to 360 days old (mature), body weight increases 52.2 times (261.1 ± 2.161), and body length 4.43 times (19.5 ± 0.225 cm). The highest rate of weight gain is observed at 90 (1922%) and 180 days (77.2%) ages, the lowest - at 360 (18.8%) and 270 days (22.7%) ages. The highest rate of increase in body length was also noted at 90 - (218.2%) and 270 days (16.0%) age, the smallest - at 180 (7.1%) and 360 (12.1%) days of development. In the experiment with irradiation up to 360 days of development, the weight of the testes increases 60 times (1.20 ± 0.023 g), the length - 6.4 times, the width - 6.5 times, and the volume of the testes - 269 times.

Conclusions

In the control group, up to mature age (360 days), body weight increases 56.8 times, and body length 4.8 times. In the experimental group, the parameters of physical development lag behind intact animals. The lag is more pronounced in the 6-month period. The morphometry of the testes showed that their weight, length, and thickness in postnatal ontogeny vary unevenly. Comparison of the rate of increase in body weight and length with the weight and volume of the testes shows that with an increase in their volume, body weight increases more than length. The weight of the testes increases 1.16 times faster than the body weight, and a high rate of growth of the testes is noted at 90 days of age. In the experiment, all anatomical parameters of the testes lag behind the control values.

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