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# THE EFFECT OF VEGETATIVE DENERVATION ON PHOTOPERIODIC CHANGES IN THE MORPHOLOGICAL STRUCTURE OF RATS' SEX GLANDS

***Abstract.*** *We have studied the features of photoperiodic changes in the weight and structure of the testes and their epididymides and accessory sex glands (seminal vesicles, prostate) in nonpubertal male white rats after surgical bilateral lumbar sympathectomy and bilateral pelvic neurectomy. Photoperiodic changes in animals had been modelled for 7 days using continuous illumination, constant darkness and natural light in the spring and summer. It was established that the vegetative denervation disturbs adequacy of photoperiodic changes in the gonads in the puberty period.*
***Key words:*** *testes, epididymides, seminal and prostate glands, photoperiodism, bilateral pelvic neurectomy, bilateral lumbar sympathectomy, male rats.*

**Introduction.** It is well known that both in male sex glands and in female ones there are seasonal changes due to the illumination rate (photoperiod): with increasing photoperiod in the spring and summer time, gametogenesis and hormonogenic function of the gonads get activated, which is accompanied by an increased morphofunctional activity of the accessory sex glands. As the photoperiod becomes shorter during the autumn-winter season there are reverse changes associated with changes in the activity of the pineal gland and hormone melatonin production [5, 8, 9].

At the same time, it has been undoubtedly proved that there is a multiple efferent innervation of the sex glands [6] and an influence of the vegetative innervation on the changes in the gonads [2]. However, there is no information in the literature on possible participation of the vegetative innervations in the photoperiodic changes in the gonads, despite the fact that the techniques of surgical peripheral denervation of the gonads are used in clinical practice, particularly for patients with chronic orchialgia [4].

**Objective:** The purpose of our study was to establish the role of the sympathetic and parasympathetic innervation in the photoperiodic changes in the gonads of laboratory rats.

**Materials and methods.** The study was conducted in the spring and summer on 155 nonpubertal male white rats aged 4–5 weeks weighing 40–60 grams. We studied the features of photoperiodic changes in the animals' weight and structure of the testes and their epididymides as well as accessory sex glands (seminal vesicles, prostate gland), morphometry parameters of these glands after surgical bilateral lumbar sympathectomy and bilateral pelvic neurectomy which were performed separately. Pentobarbital (40 mg/kg) injected intraperitoneally, and then laparotomized. For the bilateral pelvic neurectomy group (n=24), the pelvic nerves were retrieved and bilaterally dissected as described in detail by Carlson and De Feo [1]. The nerves were cut with approximately 1–2 mm removed from the nerve to avoid regeneration [3]. For the lumbar sympathetic denervation group (n=47), the chain was dissected from L2 to the aortic bifurcation [7]. Sham surgery (n=23) involved exposing, but not sectioning, the nerves.

Photoperiodic changes in animals' bodies were simulated after surgical manipulation for 7 days using continuous illumination, constant darkness and natural lighting during the spring and summer season [10]. The sex glands were embedded in paraffin wax and blocks were prepared. The sections was stained with hematoxylin and eosin and analyzed under a binocular light microscope by using screw ocular-callipers MOB-1-16x (LOMO, Russia). We measured diameters of convoluted seminiferous tubules and that of the epididymis, height of the epithelium in the epididymis tubule, of seminal vesicles and prostate on the sections of histologic specimens. Statistical analysis of the results was performed using the software Statistica 10 (StatSoft, USA). Whether the continuous variables were normally distributed or not was determined by using the Kolmogorov-Smirnov test. Descriptive statistics were represented as mean ± SD. The differences among groups in terms of mean values were evaluated by using the parametric Student's t-test, and those in terms of median values were evaluated by using the non-parametric Mann-Whitney U-test. A p value of ≤ 0.05 was considered to be statistically significant.

**Results and discussion.** It was established that in intact and false-operated animals constant light causes acceleration whereas constant darkness slows down the development of the gonads. Bilateral sympathectomy (tabl. 1, 3) under natural lighting leads to severe atrophic changes in the gonads. However sympathectomy under conditions of constant darkness and constant lighting only slightly suppresses the development of the sex glands at puberty.

After the pelvic neurectomy (tabl. 2, 4) under

**Table 1**

**The average weight of reproductive organs in immature male rats under different lighting conditions following bilateral lumbar sympathectomy in the spring and summer season (mg per 100 g of body weight, M±m)**

| Nature of exposure | Number of animals | Testes | Epididymides | Seminal vesicles and PG |
|---|---|---|---|---|
| Intact, daylight | 22 | 1146,0±71,21 | 114,8±6,60 | 101,3±5,04 |
| Pseudo-operated, daylight | 7 | 1185,1±132,29 | 120,7±20,43 | 100,8±9,12 |
| Sympathectomy, daylight | 15 | 736,7±65,17 *, ^ | 82,4±7,58 *, ^ | 72,5±3,74 *, ^ |
| Intact, permanent light | 22 | 1265,9±70,48 | 125,1±5,45 | 120,0±11,39 |
| Pseudo-operated, permanent light | 9 | 1199,8±151,63 | 127,0±19,07 | 93,4±11,44 |
| Sympathectomy, permanent light | 15 | 1010,9±82,50 # | 109,2±10,68 # | 87,7±6,27 **, # |
| Intact, permanent darkness | 17 | 873,1±94,50 *, ** | 87,7±9,56 *, ** | 85,9±8,84 ** |
| Pseudo-operated, permanent darkness | 7 | 906,7±118,06 | 87,8±11,17 | 83,4±7,47 |
| Sympathectomy, permanent darkness | 17 | 793,3±58,26 ## | 90,8±6,79 | 71,1±6,29 ## |

*Notice. * – p≤0,05 relatively to the values in the intact animals under standard light; ** – p≤0,05 relatively to the values in the intact animals under permanent light; # – p≤0,05 relatively to the values in the animals after sympathectomy under standard light; ## – p≤0,05 relatively to the values in the animals after sympathectomy under permanent light; ^ – p≤0,05 relatively to the values in the pseudo-operated animals under standard light; PG – prostate gland.*

**Table 2**

**The average weight of reproductive organs in immature male rats under different lighting conditions following bilateral pelvic neurectomy in the spring and summer season (mg per 100 g body weight, M±m)**

| Nature of exposure | Number of animals | Testes | Epididymides | Seminal vesicles and PG |
|---|---|---|---|---|
| Intact, daylight | 22 | 1146,0±71,21 | 114,8±6,60 | 101,3±5,04 |
| Pseudo-operated, daylight | 7 | 1185,1±132,29 | 120,7±20,43 | 100,8±9,12 |
| Pelvic neurectomy, daylight | 8 | 1033,6±83,54 | 97,6±6,83 | 95,7±5,04 |
| Intact, permanent light | 22 | 1265,9±70,48 | 125,1±5,45 | 120,0±11,39 |
| Pseudo-operated, permanent light | 9 | 1199,8±151,63 | 127,0±19,07 | 93,4±11,44 |
| Pelvic neurectomy, permanent light | 8 | 1195,0±40,75 # | 102,8±5,49 ** | 81,0±3,53 **, # |
| Intact, permanent darkness | 17 | 873,1±94,50 *, ** | 87,7±9,56 *, ** | 85,9±8,84 ** |
| Pseudo-operated, permanent darkness | 7 | 906,7±118,06 | 87,8±11,17 | 83,4±7,47 |
| Pelvic neurectomy, permanent darkness | 8 | 1018,8±84,22 ## | 100,1±7,27 | 84,9±7,88 |

*Notice. * – p≤0,05 relatively to the values in the intact animals under standard light; ** – p≤0,05 relatively to the values in the intact animals under permanent light; # – p≤0,05 relatively to the the animals after pelvic neurectomy under standard light; ## – p≤0,05 relatively to the the animals after pelvic neurectomy under permanent light; PG – prostate gland.*

natural lighting conditions there is only a slight inhibition of the development of gonads. Under conditions of constant light pelvic neurectomy suppresses the development of gonads less than under usual lighting, not significantly affecting the signs of photoperidism in morphofunctional development of gonads. However, after the pelvic neurectomy under conditions of constant darkness instead of the expected further suppression of gonads we did not find a significantly decrease in the identified values.

Thus, bilateral sympathectomy causes disorders in the development of the sex glands in puberty more than bilateral pelvic neurectomy, and the parasympathetic nerves provide photoperiodic changes in the gonads during puberty better than the sympathetic ones. Thus, the maintaining of vegetative innervation of the gonads contribute to the adequacy of photoperiodic changes in the gonads.

**Conclusions.** 1. Bilateral sympathectomy causes disorders in the development of the sex glands in puberty more than bilateral pelvic neurectomy.

2. The parasympathetic nerves provide photoperiodic changes in the gonads during puberty better than the sympathetic ones.

3. The maintaining of vegetative innervation of the gonads contribute to the adequacy of photoperiodic changes in the gonads.

**Prospects of further research.** To determine the role of the central divisions of the autonomic nervous system in the implementation of photoperiodic changes in the male gonads.

**Table 3**

**Morphometric values of the reproductive organs in male immature rats under different modes of light after the bilateral lumbar sympathectomy in the spring and summer season (microns, M±m)**

| Nature of exposure | Number of animals | Diameter: | | Height of epithelial cells: | | |
|---|---|---|---|---|---|---|
| | | tubuli seminiferi contorti | epididymis canal | epididymis canal | seminal vesicles | prostate gland |
| Intact, daylight | 22 | 120,4±6,82 | 105,4±6,11 | 13,8±0,55 | 8,4±0,57 | 9,4±0,70 |
| Pseudo-operated, daylight | 7 | 123,2±4,15 | 107,3±5,02 | 12,2±0,68 | 8,4±0,45 | 9,6±0,62 |
| Sympathectomy, daylight | 15 | 82,3±4,12 *, ^ | 93,5±3,83 ^ | 11,2±0,49 * | 7,1±0,31 *, ^ | 7,8±0,42 *, ^ |
| Intact, permanent light | 22 | 141,4±9,92 | 110,6±8,28 | 13,6±0,53 | 11,8±0,72 * | 11,4±0,84 |
| Pseudo-operated, permanent light | 9 | 136,8±5,67 | 112,1±7,35 | 12,4±0,69 | 11,2±0,50 ^ | 11,0±0,77 |
| Sympathectomy, permanent light | 15 | 118,7±4,51 **, ^^, # | 106,8±4,76 # | 12,3±0,62 | 8,3±0,37 **, ^^, # | 9,2±0,40 **, ^^, # |
| Intact, permanent darkness | 17 | 104,3±6,22 *, ** | 96,8±6,21 | 10,5±0,71 *, ** | 8,2±0,42 ** | 8,9±0,72 ** |
| Pseudo-operated, permanent darkness | 7 | 115,7±4,89 ^^ | 98,9±9,43 | 10,8±0,58 | 8,6±0,35 ^^ | 9,0±0,50 ^^ |
| Sympathectomy, permanent darkness | 17 | 95,8±8,97 ## | 98,6±4,02 | 11,9±0,51 | 7,6±0,35 | 9,1±0,49 # |

*Notice. ^^ – p≤0,05 relatively to the values in pseudo-operated animals under permanent light;; other symbols are the same as in table 1.*

**Table 4**

**Morphometric values of the reproductive organs in male immature rats under different modes of light after the bilateral pelvic neurectomy in the spring and summer season (microns, M±m)**

| Nature of exposure | Number of animals | Diameter: | | Height of epithelial cells: | | |
|---|---|---|---|---|---|---|
| | | tubuli seminiferi contorti | epididymis canal | epididymis canal | seminal vesicles | prostate gland |
| Intact, daylight | 22 | 120,4±6,82 | 105,4±6,11 | 13,8±0,55 | 8,4±0,57 | 9,4±0,70 |
| Pseudo-operated, daylight | 7 | 123,2±4,15 | 107,3±5,02 | 12,2±0,68 | 8,4±0,45 | 9,6±0,62 |
| Pelvic neurectomy, daylight | 8 | 118,6±5,18 | 98,5±3,41 | 11,9±0,58 * | 7,5±0,30 ^ | 8,0±0,38 ^ |
| Intact, permanent light | 22 | 141,4±9,92 | 110,6±8,28 | 13,6±0,53 | 11,8±0,72 * | 11,4±0,84 |
| Pseudo-operated, permanent light | 7 | 136,8±5,67 | 112,1±7,35 | 12,4±0,69 | 11,2±0,50 ^ | 11,0±0,77 |
| Pelvic neurectomy, permanent light | 8 | 134,5±5,82 # | 103,7±4,37 | 12,8±0,64 | 8,5±0,41 ^^, ** | 9,3±0,52 #, ** |
| Intact, permanent darkness | 17 | 104,3±6,22 *, ** | 96,8±6,21 | 10,5±0,71 *, ** | 8,2±0,42 ** | 8,9±0,72 ** |
| Pseudo-operated, permanent darkness | 7 | 115,7±4,89 ^^ | 98,9±9,43 | 10,8±0,58 | 8,6±0,35 ^^ | 9,0±0,50 ^^ |
| Pelvic neurectomy, permanent darkness | 8 | 117,3±5,26 ## | 101,9±3,28 | 12,1±0,63 | 8,1±0,33 | 7,6±0,43 ##, ^^^ |

Notice. ^ – *p≤0,05 relatively to the values in pseudo-operated animals under standard light;* ^^ – *p≤0,05 relatively to the values in pseudo-*

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