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ASSESSMENT OF THE FUNCTIONAL STATE OF SPERMATOZOA IN CONDITIONS OF COMBINED IMPACT OF PHYSICAL ENVIRONMENTAL FACTORS

ORCID ID: 0000-0002-5286-1705
Olena Litovchenko
Postgraduate
V.N. Karazin Kharkiv National University

ORCID ID: 0000-0002-8049-5925
Diana Stukalkina
Student of the First Medical Faculty
Kharkiv National Medical University

UKRAINE

Relevance. Modern technologies are accompanied by the use of a wide range of physical factors, namely the generation of electromagnetic radiation (EMR) of different characteristics, which makes a significant contribution to environmental pollution and is potentially dangerous to health. Moreover, this anthropogenic factor can have an impact in different climatic conditions. Namely, in positive low temperatures (PLT) which are a sustainable environmental state, that can cause additional stress to the body during adaptation to EMR [1]. In recent years, in Ukraine as well as in other countries, the number of diseases of the reproductive system has increased. Infertility of married couples in our country is about one million people. At the same time, up to 30% of infertility cases are associated with diseases of the male reproductive system. Impaired reproductive function contributes to the development of mutations in male gamete, which can be passed on to future generations disrupting the gene pool of the population [2]. The combined effect of environmental factors on health is realized by direct or indirect effects on the target-tissues, one of such targets is the male reproductive system. There is a need to improve methods of revealing the relationship between health and the environment, which will allow to eliminate in time the causes of impact and possible negative consequences.

The aim of the study was to determine the functional state of spermatozoa under the combined effects of EMR and PLT and to determine which of the factors has a more negative impact.

Methods and materials. In the laboratory, a 30-day experiment was simulated on male WAG rats (n = 24), which were divided equally into 4 experimental groups: a group of isolated exposure to PLT (+4±2°C), a group of isolated exposure to EMR (70kHz, 600 V/m), a group of combined exposure to EMR and PLT and a control group. The experimental groups were exposed to factors for 4 hours 5 times a week. Biological material (sperm suspension from the epididymis) was studied on the 5th, 15th and 30th days. The experiment was conducted in full compliance with the European Convention for Protection of Vertebrate Animals Used for Research and Other Scientific Purposes (Strasbourg, 1986). To achieve the goal, the following statistical methods were used: Mann-Whitney U-test and cluster analysis (fuzzy-c-means).

Results. When studying the functional state of spermatozoa, the phase changes of indices were noted both by the criterion of their qualitative changes and by the criterion of the number of indices that changed.

Thus, on the 5th day, the changes concerned six indices, namely a decrease in: the total concentration of sperm by 144% relative to control ($p<0.03$), the number of motile sperm by 25% ($p<0.04$), the time of sperm movement by 134 % ($p<0.03$), the concentration of morphologically normal forms by 115% ($p<0.008$). At the same time, there was an opposite increase in the number of immobile sperm by 91% ($p<0.04$) and an increase in the concentration of pathological forms of sperm by 152% ($p<0.005$).

On the 15th day, changes occurred in four indices only: the number of motile sperm increased by 25% ($p<0.01$), and the concentration of pathological forms of sperm was increased by 115% ($p<0.01$), acid resistance was increased by 20% ($p<0.03$), simultaneously a decrease in the number of immobile cells by 206% ($p<0.01$) was found. We regard the revealed changes and reduction in the number of shifts in indices as a compensatory reaction.

During the long-term exposure to the combined action of factors (30 days), the qualitative changes were similar to the initial ones, but more pronounced. Thus, the number of motile sperm on the 30th day decreased by 58% compared with the control and reached minimal values for the entire observation period ($p<0.005$), the duration of motility was again less than the control by 57% ($p<0.01$), the concentration of morphologically normal forms was reduced by 75% ($p<0.04$). At the same time, the number of immobile sperm was increased by 102% ($p<0.005$) and such a significant index as the number of dead cells added, which increased sharply by 2311% ($p<0.005$). In contrast to the above indices, which had phase changes, the concentration of pathological forms increased throughout the experiment and reached its maximum value by the end of the experiment, increasing by 268% ($p<0.008$).

The degree of membership of the groups of isolated action to the group of combined action of factors was determined with cluster analysis. The degree of membership of the EMR effect to the combined effect of factors was for PLT mu_X = 0.4545, and for EMR mu_E = 0.5455. That is, the largest negative contribution is made by EMR - 54%. The effect of PLT on the reproductive function is more prolonged.

Conclusions. Studies of the combined effect of EMR and PLT allowed to assess the functional state of spermatozoa, which was characterized by suppression of reproductive function, to determine the leading role of EMR in the development of revealed pathologies. Thus, the tested mathematical approach allows to determine the individual contribution of the factor under the conditions of combined effect, to predict probable corresponding reactions of the reproductive system, which will allow to substantiate adequate preventive measures in the future.

References:

[1] Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields). eur-lex.europa. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013L0035&rid=2 [in English].

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