

Pathology of the Genitourinary System in Women Who Received Radiation Exposure with Radioactive Iodine During Pregnancy as a Result of the Accident at the Chernobyl NPP

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Abstract

We studied the long-term morbidity of the genitourinary system of women irradiated during pregnancy with radioactive iodine as a result of the accident at the Chernobyl nuclear power plant, which accumulated in the thyroid gland, in comparison with that of women whose pregnancy proceeded in the absence of the effect of the radiation factor. The incidence rate in the group of exposed women since 2001 has been higher than in the control group. Chronic inflammatory diseases of the genitourinary system prevailed in the group of exposed women, in contrast to the incidence in the group of non-irradiated women. These changes in the incidence of irradiated pregnant women were associated with two ranges of absorbed doses - 74 mGy and 160 mGy. The detected changes are discussed in this article from the point of view of the sensitivity of certain thyroid genes to the effects of I-131, changes in the production of hormones and disruption of their influence on certain organs and systems of the body.

Keywords: Radioactive iodine; Thyroid gland; Pathology of genitourinary system

Introduction

In our previous studies, we analyzed the morbidity of women who were irradiated with radioactive iodine (I-131) during pregnancy as a result of the accident at the Chernobyl nuclear power plant. The iodine released into the atmosphere accumulated in the thyroid gland, forming varying absorbed doses. Their morbidity was compared with that for a control group of women in relation to pathologies of the cardiovascular, digestive, nervous systems and etc. In a number of cases, an increased morbidity was noted in the irradiated group of women for some nosological forms [1-3], while we did not observe such differences in the categories of gastrointestinal tract and endocrine system diseases [4,5]. Analysis of dose dependence, i.e., determination of the effect of the received dose on the occurrence of diseases, has brought interesting, surprising and unusual conclusion. Cases of some diseases occur much more frequently in women who received certain doses due to the incorporation of radioactive iodine. At other, higher or lower doses, such dependencies were not found. This contradicts generally accepted data on the effects of radiation on the body, although the general somatic effects due to radiation have been studied very poorly. However, in this case the following must be kept in mind. Our studies deal with pathology that may be associated with the function of the thyroid gland, which has

received irradiation and which in its turn affects the functions of many organs and systems [6]. Therefore, we hypothesized that the observed effects may be due to the effects of I-131 on certain genes in thyroid cells. They are involved in cell metabolism, as well as in the synthesis of thyroid hormones, which regulate the functions of many body systems. Characteristic dose-dependent effects may be associated with their imbalance. In the present study, we examined the incidence of genitourinary tract morbidity in irradiated pregnant women in comparison with women who were not exposed to radiation.

Case Series

The study included women who, in the first days after the accident at the Chernobyl nuclear power plant, were at different stages of pregnancy and lived in the Stolin district of the Brest region. Immediately after the accident, a radioactive cloud passed through this area, which, in addition to a wide range of radionuclides, contained iodine isotopes (I-131, I-133, etc.), which entered the body of residents by inhalation and orally, accumulated in the thyroid gland and formed thus, different absorbed doses. The cohort of these women included 221 residents of the Stolin district of the Brest region.

As a comparison group, the study included women from the

same Stolin district of the Brest region, whose pregnancy was recorded later, i.e., in 1987. Due to the short half-life of I-131 (8 days) after a year, i.e., in 1987, there was almost no radioactive iodine in the environment and it had no effect on pregnant women. However, the same living conditions in the Stolin region, the same radiation exposure from the contaminated area, and their social status served as good conditions for selecting a control group. The comparison group included 40 women.

Data on morbidity were obtained from the State Register of Persons injured as a result of the Chernobyl accident. The work used only the data from refined diagnoses for primary morbidity.

Statistical data processing was carried out using applied computer programs Statistics 10.0 (StatSoft. Inc, USA) and SigmaPlot 12.5 (Systat Software Inc., Germany).

In the beginning of the study, we were primarily interested in the structure of diseases of the genitourinary system and its comparison with a cohort of non-irradiated women. **Figure 1** shows these data. We combined groups of diseases with occurrences less than 2% into the "Other" category. As you can see, the list of nosological forms in both groups is very similar, however, there are differences in the prevalence of one or another pathology. In irradiated women, inflammatory kidney diseases (N11 - chronic tubulo-interstitial nephritis) and other diseases of the genitourinary system (N39) was in the foreground. Calculus of kidney and ureter was present in third place (N20) and accounted for about 14%. On the contrary, in the control group of women, i.e. in those whose pregnancy occurred later and they were not exposed to I-131, the mentioned pathology dominated and accounted for almost half of the overall morbidity structure. This, from our point of view, is an interesting fact that may indicate the effect of radioactive iodine on the thyroid

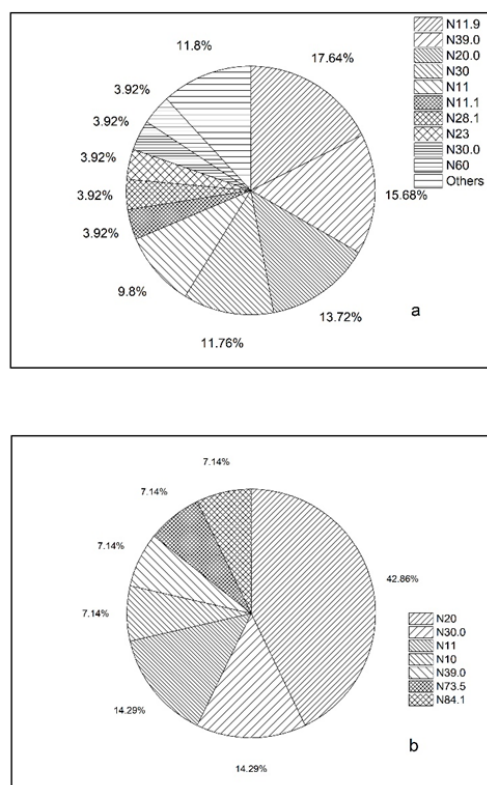


Figure 1: Structure of morbidity of the genitourinary system in pregnant women who were exposed to radioactive iodine (a) and a control group of women (b).

gland (inhibition of its effect on the activity of the immune system), which can contribute to the progression of infectious pathologies of various types in the body [7] including observed inflammatory kidney diseases.

At the second stage of the research, it was interesting to analyze the cumulative incidence in two groups of women. The study of this indicator is an adequate method of epidemiological analysis due to the fact that homogeneous and similar groups of subjects (pregnant women) are compared, whose age is almost the same as well as their social status. **Figure 2** shows the cumulative incidence of urogenital pathology for two groups of women. In this study, we analyzed the incidence of diseases of the genitourinary system from 1986 to 2016. All cases of this pathology were recorded. The figure shows clear differences in incidence. Before 2000, the slope of both curves is almost the same. Later, starting from 2001, the incidence among irradiated women rises sharply, exceeding that in the control group.

Finally, at the third stage of the study, it was very interesting to investigate the dose dependence of the appearance of this pathology, depending on the generated doses to the thyroid gland. This analysis took into account all groups of pathologies of the genitourinary system of women. **Figure 3** shows these results. The peak search result was characterized by a good determination coefficient (COD) of 0.98. As in a number of other cases related to the study of the morbidity of organs and systems discussed above, we were able to identify two ranges of doses that affected the morbidity of the genitourinary system. The

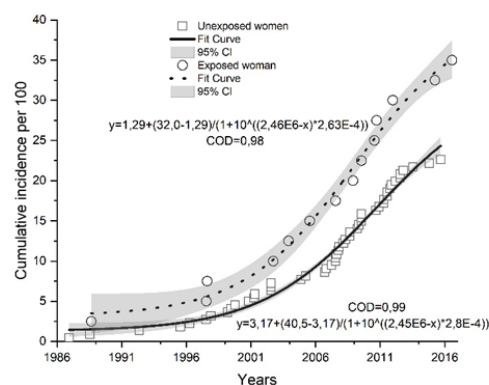


Figure 2: Cumulative incidence of genitourinary system organs in pregnant women irradiated with radioactive iodine and subjects in the control group.

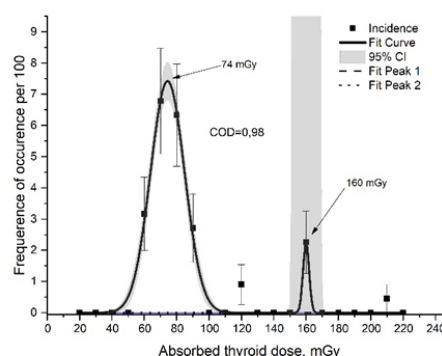


Figure 3: The influence of formed doses on the thyroid gland of pregnant women on the incidence of the genitourinary system.

main peak was in the region of absorbed doses by the thyroid gland equal to 74 mGy, the second, smaller peak was for doses equal to 160 mGy. It was very interesting to compare the detected peaks with dose dependence data in other organs and systems. In the case of the respiratory system, there was single incidence maximum for absorbed dose in the region of 75 mGy [3]. A similar picture was revealed after the analysis of the incidence of diseases of cardiovascular system. However, in this case, there were two maxima of absorbed doses, which served as a trigger for the appearance of pathology among irradiated women (70 and 160 mGy) [8]. The manifestation of essential hypertension in women was associated with maxima of absorbed doses at values of 63 and 160 mGy [9]. The coincidence of absorbed doses in relation to the effects on various organs and systems is surprising. This is especially true for exposure to a dose in the 160 mGy region, which was associated with an increase in morbidity from the cardiovascular and genitourinary systems. One explanation of this fact may be the effect of I-131 on certain thyroid genes, as discussed below. It has been convincingly shown that some thyroid genes are capable of changing (increasing or decreasing) their expression being exposed to radioiodine [10].

A total of 27 of such genes were discovered. Some of them, by regulating certain biochemical processes (calcium binding, energy production, etc.), take part in the functioning of the body's immune system. These include chemokine ligand 8 with the CC motif (CCL gene), calcium binding protein A9 S100 (S100A9 gene), amino oxidase (AOC3 gene), etc. The effect of I-131 on these genes may be associated with changes in the inflammatory reactions of various organs, as well as changes in the activity of the immune system [11]. This may explain changes in morbidity, including inflammatory reactions of various organs and systems, such as genitourinary and respiratory systems. We are inclined to explain the appearance of another peak of absorbed doses, in the region of lower values (60-75 mGy), by the effects of radiation on other genes. These include, for example, the Scara3 gene, the function of which is to regulate the oxidative stress system that can influence the process of synthesis of thyroid hormones, which regulate, in particular, vital functions including the activity of cardiovascular and respiratory systems. Such changes can be fixed as a result of radiation-induced genomic instability and serve as the basis for delayed pathology development [12].

Conclusion

Thus, irradiation of the thyroid gland in women during pregnancy with radioactive iodine contributes to the growth of pathologies of the genitourinary system, mainly of an inflammatory nature. This growth is facilitated by the formation of absorbed doses to this endocrine organ in the region of 75 and 160 mGy.

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Authorship Criteria

Stojarov A.N. Concept and design of study. Guarantor.

Khrustalev V.V. Revision of the manuscript critically for important intellectual content.

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