



Cytogenetic effects in human as the result of the Chernobyl accident

M. A. Pilinskaya

Research Centre for Radiation Medicine,
Academy of Medical Sciences of Ukraine, Kiev, Ukraine

ABSTRACT

The Chernobyl accident significantly complicated the ecological situation in Ukraine. The existing environmental pollution, which was already rooted in the background, ensures for the most part that the Ukrainian population comes into contact with one of the most powerful universal mutagens - ionizing radiation. This can cause genetic damage in all living beings, including human. As such, it is essential that the Chernobyl accident victims be medically monitored using cytogenetic monitoring – the study of the frequency and spectrum of chromosome aberrations in human peripheral blood lymphocytes with the help of classical (conventional cytogenetics, G-banding analysis) and new (FISHWCP) research methods.

Keywords: cytogenetic effects, human, Chernobyl accident

INTRODUCTION

A report included the results of this monitoring, which was conducted by the scientists from the cytogenetic lab of RCRM AMSU since January 1987 until now. The results indicated that among the exposed groups of high priority were patients recovering from acute radiation sickness, such patients included clean-up workers mainly from the 1986 and 1987 cleanup efforts, Chernobyl power plant personnel, Sarcophagus workers, self-settlers from the 30-km exclusion zone and children and adults from areas of mandatory and voluntary evacuation.

The data received about the dose-dependent rise of the frequency of chromosome aberrations in examined groups had been in agreement with the results of other authors and confirmed that in fact there was an increase of the somatic chromosome mutagenesis

intensity; which was induced by Chernobyl accident factors, on the background of general ecological and social despondency that allows to consider this accident as a new ecogenetic factor for population of Ukraine.

It has been shown that even so called "low" human doses of ionizing radiation under prolonged exposure can be "doubling" on cytogenetic criteria and induce specific chromosome damage in cells-indicators (human peripheral blood lymphocytes), which are not only biomarkers of radiation mutagenic exposure, but cause the death or functional disturbance of target cells (somatic and germinal). This can be the basis for the origin of stochastic and possibly some nonstochastic effects of mutational characters (particularly multifactorial pathology).

The most important areas for further scientific investigation are the in-depth study of the radioinduced, so called "disgenomic effects" (adaptive response, chromosome instability - delayed, hidden, transmissible - and "bystander effect") as well as the comparison of primary structure chromosomal damage with known harmful health effects due to human irradiation. Such research will provide the opportunity to obtain unique data, from the contribution of radiogenic genomic injuries to the outcome of delayed medical consequences of radiation accidents.

The Chernobyl accident significantly complicated the ecological situation in Ukraine and on the background of already existing environmental contamination, promoted that great part of the Ukrainian population become increasingly in contact with one of the most powerful universal mutagens - ionizing radiation. This type of radiation can cause genome damages in all living beings including human. As it is known, only radioinduced genetic damage can be base for the appearance and development of both stochastic effects (hereditary pathology, oncological pathology) and non-stochastic effects with mutational characteristics (multifactorial pathology, congenital malformations).

Therefore, it becomes necessary for Chernobyl accident victims to be under medical observation by selective cytogenetic monitoring – the study of the frequency and spectrum of chromosome aberrations in human peripheral blood lymphocytes with the help of classical (conventional cytogenetics, G-banding analysis) and new (FISH-WCP) methods of the investigation.

Such monitoring has been conducted in the cytogenetic lab of RCRM AMSU since January 1987 till now, among priority groups of the Ukrainian population that suffered from the influence of the Chernobyl accident effects - patients recovering from acute radiation sickness, clean-up workers mainly from the 1986-1987 years, children from areas of mandatory or voluntary evacuation, evacuees, people living or working in the 30-km. zone of alienation (including Sarcophagus); the majority of whom (liquidators, children and adult population of the Ukrainian territories contaminated with radionuclides) one can suppose have been under the influence of low intensity radiation , with doses mainly less than 25 sGy.

It had been established that in all examined groups, a high level of cytogenetical markers of irradiation has remained. Its mean group values depended on the character and intensity of radiation exposure and its individual values probably were conditioned by the individual susceptibility of human organism to the identical radiation exposure.

A number of articles on the results of the cytogenetical examination of Chernobyl accident victims (mainly liquidators of different years as well as children and adults from territories of the Commonwealth of Independent States and some countries of Western Europe such as Germany and Austria) had been published by 2005 in some near by (Ukraine, Russia,

Belarus, Estonia, Latvia) and some remote (Germany, Italy, Great Britain, the Netherlands, USA, Israel) countries. Radioinduced cytogenetic effects had been revealed in the majority of the examined groups, the extent of its expression depended on the intensity, duration, conditions of irradiation, time following the accident and in some cases on specific treatment of radiation-induced injuries [1-10].

The results obtained from the selective cytogenetical monitoring (which are indicators of general mutagenic load for the examined contingents) had been in agreement with the data received by colleagues from Ukraine and other countries, and this confirmed the fact that there is a dose-dependent increase in the intensity of somatic chromosome mutagenesis in humans, which was induced by Chernobyl accident effects on the background of general ecological and social despondency, which allows to consider this accident as a new ecogenetic factor for the population of Ukraine.

It has been shown that prolonged exposure of even so called “low” doses of ionizing radiation can induce specific chromosome damage in human peripheral blood lymphocytes and more than double the increase of spontaneous chromosome mutations. Such primary damages of the genome at the chromosome level are not only biomarkers of radiation exposure and biodosimeters of absorbed radiation, but by causing the disturbances of the normal function of target cells, can also be the basis for finding stochastic and possibly, some non-stochastic postradiation effects with genetic components.

Interindividual variability in frequency of radio-dependent chromosome aberrations that have been observed under even identical conditions of irradiation can serve as an indicator of human individual sensitivity to mutagenic factors including ionizing radiation.

At the same time, the data obtained allows to suggest that there are such lower levels of irradiation in which cytogenetical effects in some individuals are either not induced; or are induced but can be repaired; or are not identified by current approaches and methods which is a limiting factor in studying the cytogenetical effects of low radiation doses.

The most important and perspective areas for further scientific research in the field of human radiation cytogenetics are profound studies of radioinduced “digenetic effects” (adaptive response, “bystander effect” or chromosome instability: delayed, hidden, transmissible); which we have been doing during the last several years [11-23], and also comparison of primary structure chromosome damage with developed harmful health effects due to human irradiation.

CONCLUSION

Such investigations will enable to get unique data about contribution of radiogenic genomic injuries to realization of delayed medical consequences of radiation accidents, which will finally allow basing scientific measures directed for minimizing of such consequences. A cardinal solution of that problem can only be possible within the frames of a wellfinanced international scientific-technical program what will allow joint efforts of scientific groups working in this field.

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