"Physics of Auroral Phenomena", Proc. XXIX Annual Seminar, Apatity, pp. 305 - 307, 2006

Polar Geophysical Institute

THE INFLUENCE OF GEOMAGNETIC FIELDS ON HUMAN CELLS ABILITY FOR REPAIRING DNA DAMAGE

I.N.Perminova, E.V.Perminova, M.N.Yakovleva, A.L. Kosova *(Polar Geophysical Institute, Apatity, Russia)*

Introduction

The problem of estimation of consequences of magnetic disturbances for human health remains one of the least investigated and simultaneously the most interesting and relevant questions today. Investigations of human genome stability are recognized the most informative under permanent low intense influence of geomagnetic activity since they enable one to estimate the risk of developing long-term health effects at early pre-clinical stages and to provide important information on methods of genome protection. A system of preventive measures can be developed on their basis. However, at present a small number of studies are devoted to this question, which is partly due to the complexity of such investigations and data interpreting.

Based on the assessment criterion of structure chromosome alterations, *Chebotarev et al. (2002)* showed that it was the Earth magnetic field variable component of heliogeomagnetic factors, which impacted the genetic structures. *Liboff et al. (1984)* in the experiment established that the replicative DNA synthesis in human fibroblasts was modified by the time-varying magnetic fields. There are data on probable carcinogenic effect of low frequencies magnetic fields *(IARC Monographs, 2002).*

The studies of one of the basic parts of genome protective system - the DNA repair system - give an important information both about genotoxic effects of the impact, and the ability to repair DNA damage. Changes in the repair activity result in the accumulation of mutations, which, in turn, enhance the risk of development of congenital malformations, oncological pathology and other diseases.

The Kola region is a unique province to investigate the health effects under the heliogeophysical factors exposure. However, it is necessary to take into account that the unfavorable effects of low-dose exposure to heliogeophysical factors are increased by high intensity pollution of the environment with heavy metals and depend on such individual human characteristics as genotype, life style etc.

Methods

Repair synthesis levels have been evaluated in peripheral blood lymphocytes from practically healthy volunteers by index of unscheduled DNA synthesis (UDS) induced by different mutagens ($NiSO_4$, 4-nitroquinoline-1-oxide (4NQO), $CdCl_2$, UV-rays). Blood was sampled in different phases of the 23-ird Solar cycle: December, 1997, January, 2001, November, 2004, and September, 2005. All periods of sampling (except 2005) can be defined as «a quiet period» by some of the heliogeomagnetic indices.

The results obtained in November, 2004 («the quiet period») (n=18) were compared with the data obtained in September, 2005 three days after flash on the Sun (the Forbush-effect was observed) (n=9) (see Fig.1).

At paired comparison 7 values were obtained. The specific features characterizing the life style of volunteers, which also can essentially modify the UDS index, were taken into account. The use of lymphocytes as a subject of inquiry lets us to evaluate directly and correctly health effects of exposure, individual distinctive features and to forecast the long-term exposure effects and match the most effective protectors and the scheme of their administration as well. In the present study we have also considered the following individual features characterizing a volunteer life style: age, smoking status, alcohol consumption, diet and biologically active food supplements etc. – that can appreciably affect the UDS index.

Results and discussion

The experimental data analysis do not reveal any significant differences between UDS levels obtained in a "quiet period" of geomagnetic conditions in 1997, 2001, 2004 ($p>0.05$). The average values of DNA repair (av. geom.) correspond to the low rate value (UDS=1.01-1.15) with the average level for the population in the Far North -1.0-1.2 *(Osipova et al., 1998, Perminova et al., 2001).*

During the solar flash in September, 2005 accompanied with geomagnetic disturbance the repair level in lymphocytes differed essentially from the levels obtained in the "quiet periods" of geomagnetic field. UDS value induced by $CdCl_2$ observed in September, 2005 was significantly lower ($p=0.03$) than in a "quiet period" in 2004 and was equal 0.88 (n=7), that is the DNA repair inhibition was observed (UDS<1.0) (Fig. 2).

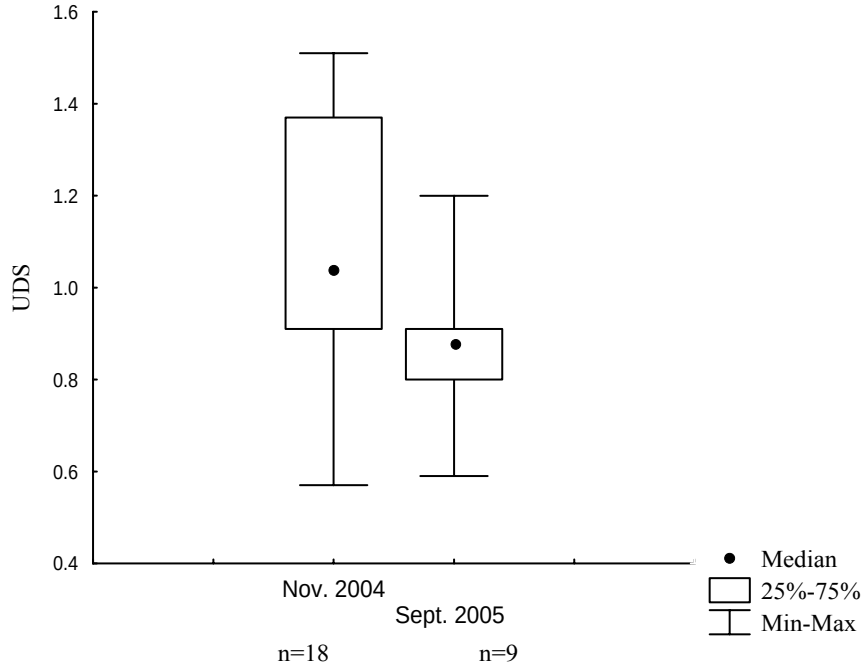

Figure 1. UDS in human lymphocytes from practically healthy volunteers in November, 2004 («a quiet period») and in September, 2005 (the Forbush-effect was observed).

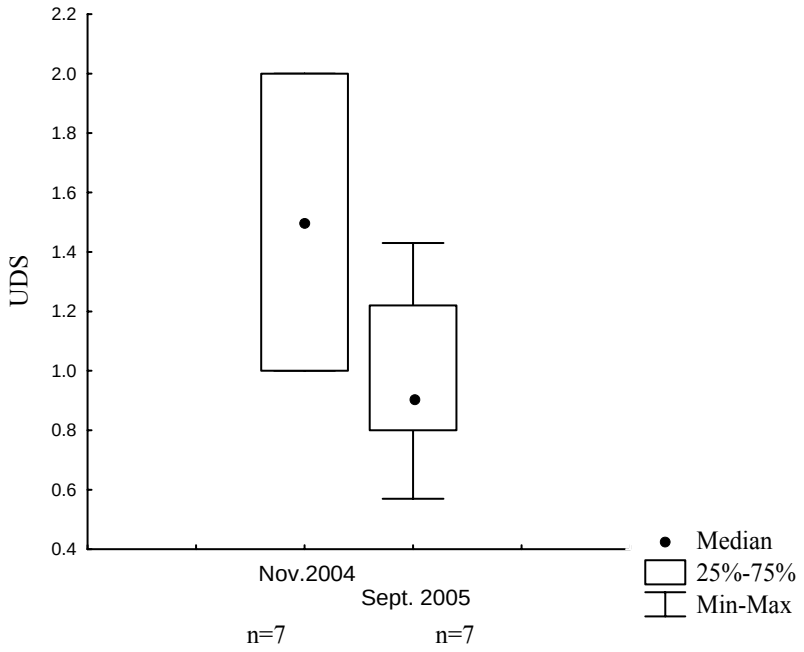

Figure 2. UDS in human lymphocytes from practically healthy volunteers in November, 2004 («a quiet period») and in September, 2005 (the Forbush-effect was observed) (n=7, at paired comparison).

It is necessary to note that during the magnetic storm in 2005 the variability of DNA repair activity index in lymphocytes was lower, than in a "quiet period" in 2004 (see Fig. 2, 3). Thus, clear-cut distinctions in individual sensitivity to geomagnetic factor influence were observed and they increased the variability of group values as a whole that was caused by a genotype (Fig. 3).

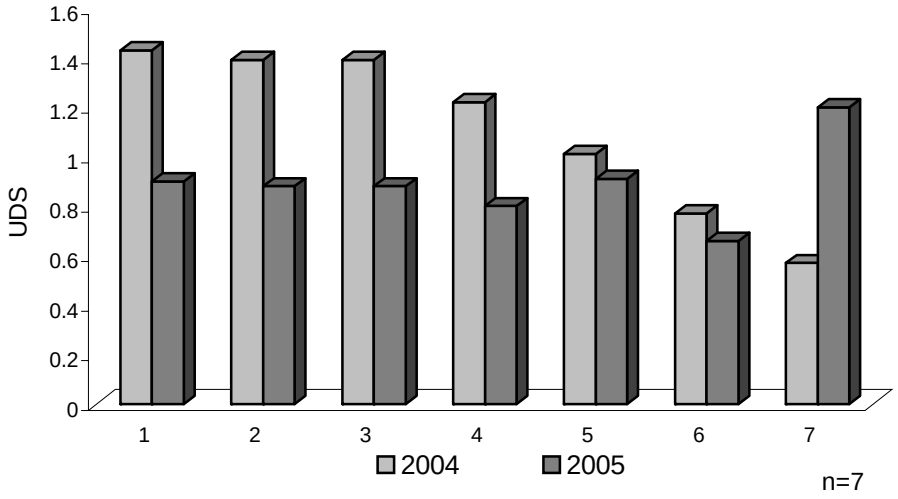

Figure 3. Individual sensitivity by the index of unscheduled DNA synthesis (UDS) in human lymphocytes in November, 2004 («a quiet period») and in September, 2005 (the Forbush-effect was observed) (n=7, at paired comparison).

Conclusions

Obviously, the significance of UDS values distinction at the periods differing in solar and geomagnetic activity points to the fact that the solar flash and the changes in geomagnetic parameters associated with it under the observed Forbush-effect influence the repair processes revealed in their inhibition. Perhaps the revealed UDS decrease in human lymphocytes is associated with balance disturbances of endogen antioxidants and free radicals during geomagnetic field modifications. It is known that during magnetic storm the lipid peroxide oxidation level is increased and in particular as a result the endogen antioxidant supplies including vitamins neutralizing surplus of free radicals that are generated under the affect of several physical and chemical factors.

In order to describe the correlation between heliogeophysical indices involved and genome response it is necessary to proceed the investigations over the periods discriminated in geomagnetic activity and complete with some other genome stability parameters. At present the micronuclei analysis is carried out in voluntaries lymphocytes that will supplement the UDS data and permit to interpret more correctly the revealed individual distinction.

References

Chebotarev A.N., Bochkov N.P., Oraevski V.N., Canonidi H.D., Mitrofanova T.A., Katosova L.D., Platonova V.I. Influence of change geomagnetic fields on frequency chromosome aberration in human cells // Proceedings of Russian Academy of Science, 2002, V.384, 4, 566-569.

IARC Monographs. Non-ionizing radiation. Pt.l: Static and extremely low-frequency electric and magnetic fields, 2002,V.80,1- 429.

Liboff A.R., Williams T., Strong D.M., Wistar R. Time-varying magnetic fields: effect on DNA synthesis. Science,1984,V.223, 4638,818-820.

Osipova T., Sinelshchikova T., Perminova I, and Zasukhina G. DNA Repair in Cultured Human Cells Treated with Nickel Sulfate and Its Modification. Russian Journal of Genetics, V.34, 6, 704-707.

Perminova I., Alekhina N., Sinelshchikova T., Osipova T., and Zasukhina G. Sister Chromatid Exchanges and DNA Repair Synthesis in Workers Exposed to Nickel Compounds. Russian Journal of Genetics, 1997, V. 33, 4, 458-461.