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SEASONAL VARIATION OF MAGNETIC STORM INFLUENCE ON MYOCARDIAL INFARCTIONS

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Abstract

The analysis of the daily numbers of Moscow ambulance calls (1979–1981), related to the myocardial infarction (MI), has been shown the seasonal variations with the profound summer minimum and winter maximum. Similar results we obtained by analyzing the 25 year (1970-1995) statistical monthly data on the death from infarction in Bulgaria. The estimated high correlation coefficient (0.84) between Moscow and Bulgarian data suggests a common reason. There are a great number of clinical and statistical studies confirming that the MI number rises during geomagnetic disturbances, which have a maximum of occurrence near equinox, not in winter. We analyzed the seasonal biotropic efficacy of the 129 geomagnetic storms with Dst from –50 nT to –250 nT, and found that about of 80% of the spring/autumn magnetic storms and about of 90% of the winter ones were accompanied by MI enhancement, but only ~ 3% of magnetic storms in summer were accompanied by the MI enhancement. We also found that the different magnetic storm phases demonstrate the different MI influence. As a rule, the storm main phase was not accompanied by the MI enhancement. The storm recovery phase typically leads to MI increasing as well as the Pc1 pulsation occurrence and Pc5 pulsations amplitude enhancement. We suggest that a seasonal variation of the production of the pineal hormone melatonin leads to a stronger summer stability in the human organisms to the "negative" influence of magnetic storms and geomagnetic pulsations in summer season. That must always be kept in mind in all investigations of the biophysical effects the geomagnetic activity.

Introduction

Very many authors accept geomagnetic storms and solar flares as one of the strong hazard factor of the human health. It was found (e.g., Cornelisson et al., 1994; Watanabe et al., 1994; Baevsky et al., 1994) that the main targets of the solar and geomagnetic activity influence are the heart and the cardio-vascular system. A strong correlation between the geomagnetic and solar activity and the myocardial infarction was demonstrated in many papers [e.g., Novikova and Ryvkin, 1971; Karazjan, 1981; Temurjanz et al., 1982, Rapoport et al., 1995, Breus et al., 1995, Chibisov et al., 1995; Gurfinkel et al., 1995, Breus and Rapoport, 2003 and many others]. However, some authors [e.g., Lipa et al., 1976] did not find the correlation between the infarction mortality in USA and the geomagnetic activity. It means that not every magnetic storm leads to infarction enhancement. In our paper [Kleimenova et al., 2007] it was shown that Pc1 geomagnetic pulsations could be one of potential hazard of the myocardial infarction and these pulsations presence in the progress of magnetic storm reinforces the magnetic storm "negative" influence.

The aim of this study was to investigate a seasonal efficacy of the magnetic storm influence on the myocardial infarction (MI) enhancement on the base of the daily numbers of Moscow ambulance calls in 1979–1981.

Analysis results and discussion

The present work demonstrates the analysis results of the ambulance calls in Moscow during 1979-1981 years on the occasion of the myocardial infarctions (85,700 events), sudden deaths (71,680 events), insults (98,500 events) and hypertension crises (165,500 events).

We found that the seasonal variations of the Moscow ambulance call numbers, related to different diseases of the cardio-vascular system (Fig. 1), are characterized by the same seasonal regularity as it was shown by Ivanova et al. (2002) for the infarction mortality in Bulgaria. Namely, it was the profound summer minimum and the winter time maximum. All of these cardio-vascular system diseases (Fig. I, upper panel) demonstrated the same seasonal dependence. The similar season variation of occurrence is typical for Pc1 pulsations. The very strong correlation (R=0.84) between the Moscow and Bulgaria data was found [Kleimenova et al., 2007]. It should be noted that the seasonal variations of the medical data do not coincide with the seasonal variations of the geomagnetic activity with equinox maxima.

In 1979-1981 there were observed 129 magnetic storms with Dst from –50 nT to –250 nT. Their seasonal distribution is given in the Table 1. The second column of this table demonstrates the number of storms accompanied be the myocardial infarctions enhancement (based on Moscow ambulance calls).

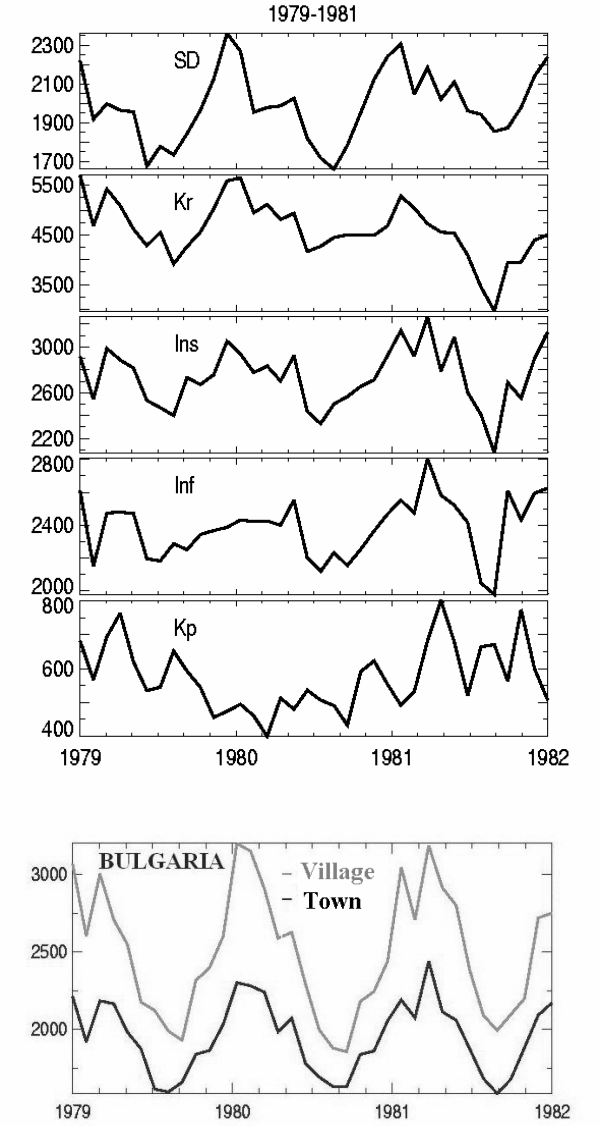

Figure 1. The monthly Moscow ambulance call numbers, related to different diseases of the cardio-vascular system: the sudden deaths (SD), the hypertension crises (Kr); the insults (Ins) and the myocardial infarctions (Inf); monthly Kp data; bottom panel: monthly infarction mortality in Bulgarian towns and villages.

Table 1. Magnetic storm occurrence

Season	Storms	infarction (MI) enhancement	%
Equinox	75	56	~75
Summer	32	1	~3
Winter	22	21	~95

Thus, more then 95% of the winter storms showed the MI enhancement, but only about 3% of the summer magnetic storms do that. We found that in summer, even very strong magnetic storms with Dst ~ 250 nT and the Pc1 pulsations presence, were not biotropic, while in the winter time even small magnetic storms with Dst ~ 50-60 nT become biotropic and showed the MI number increasing. There were 17 winter magnetic storms accompanied by the very large MI ambulance call numbers, up to 120 calls in the day, it was about 50% higher then the averaged value.

We also found that the different magnetic storm phases demonstrated the different MI influence. As usually, the storm main phase was not accompanied by the MI increasing, except the events when the storm main phase was developed on the recovery phase of the previous storm. The most part of the storm associated MI increasing was observed during the storm recovery phase as well as Pc1 geomagnetic pulsations.

We continued our investigations of the "negative" influence of Pc1 pulsations on diseased people. It was found some human adaptation to the Pc1 occurrence in the series of the succeeding days. The MI enhancement was observed only in the first day of Pc1 occurrence and later this MI number continuously decreased.

Another possible agent of magnetic storm "negative" influence could be the Pc5 geomagnetic pulsations (T~ 3-10 min, f = 2-7 mHz) due to their high temporal gradient of magnetic field, as it was suggested by Kleimenova and Troitskaya (1992). These pulsations are characterized by the very strong amplitude, even at the middle latitudes they range ~ 40–100 nT (in auroral zone up to ~ 200–500 nT). The speed of Pc5 magnetic field changing may be as high as ~100 nT/min, i.e., 5-10 times faster than the Dst-variation time change even in progress of a strong magnetic storm. Diurnal occurrence maximum of these pulsations is observed at 05 - 12 MLT. Pc5 pulsations as well as Pc1 ones are typical wave phenomena in the recovery phase of a magnetic storm. We found that the seasonal distribution of the Pc5 amplitudes demonstrates the similar summer minimum as the cardio-vascular system diseases (Table 2).

Table 2. Average number of Moscow ambulance calls in 1979-1981 and Pc5 amplitude (in arbitrary units)

	Winter	Spring	Summer	Autumn
Infarction	81.6	82.3	71.2	78.3
Insult	97.2	95.3	78.8	88.8
Stroke death	72.2	66.1	58.5	65.2
Hypertonic crisis	170	159	131	145
Pc5 amplitude	163	191	117	170

Any correlation between Pc5 amplitude enhancement and simultaneous MI increasing was found. Often the MI increasing was recorded 1-3 days later than the Pc5 amplitude maximum, but it was not observed in summer. Unfortunately, the possible "negative" influence of Pc5 pulsations on sick persons did not investigated till now. However, it seems reasonable that the Pc5 pulsations does not affect to MI as strong as Pc1 ones.

We suggest that summer minimum of the cardio-vascular system disease could be due to availability of some physiological factors making human organisms stronger in summer than in winter. We suppose that sensitivity of human organism is violated during the winter time due to instability related to the lack of luminosity and suppression of the pineal gland hormone

– melatonin production of [e.g., Arendt, 1995]. Malinovskaya et al. (2004) have studied an influence of the magnetic disturbances on the daily melatonin production of the sick and healthy people. They observed 42 patients suffering by pathology of cardio-vascular system and 7 healthy volunteers under quiet geomagnetic conditions and during magnetic storms. It was found that under quiet geomagnetic conditions the daily melatonin production of both groups was similar. However, during magnetic storms the sick person melatonin production decreased up to ~20%, while healthy person melatonin did not change.

The melatonin is well known as a multifunctional key regulator of the circadian rhythms. In addition, the melatonin is an immune modulator and antioxidant for the cardio-vascular system, and the seasonal variations in its production play a critical role in the seasonal intensify of various pathologies of the cardio-vascular system [Malinovskaya et al., 2004]. The melatonin production disruption may also play an important role in some mechanisms of coronal pathology [e.g., Sakotnik et al., 1999].

Melatonin is responsible for adaptation and is a main driver of circadian rhythms. Its production strait depends on the solar luminosity and can violate normal circadian rhythm structures which led to desynchronizes and instability. The melatonin production decreases in winter period due to decreasing of the solar luminosity, and that makes sick persons more sensitive to geomagnetic storms and geomagnetic pulsations.

Conclusion

1. The strong seasonal variations of the infarctions and other cardio-vascular system diseases demonstrate the winter maximum and the strong summer minimum which does not coincide with the seasonal variations of the solar and geomagnetic activity with equinox maxima.
2. The different magnetic storm phases demonstrate the different MI influence. Usually the storm main phase was not accompanied by MI increasing, except the events when the storm main phase was developed on the previous storm recovery phase. The most part of the storms associated with MI increasing was observed during the storm recovery phase
3. A “negative” influence of magnetic storm and geomagnetic pulsations on the patients with the cardio-vascular system diseases strongly decreases in summer, but in the winter time it increases. .
4. We suggest that the seasonal variations of the pineal hormone melatonin production, caused by seasonal sun luminosity changing, lead to a stabilization of human organisms in the summer time on a “negative” influence of magnetic storms and geomagnetic pulsations.
5. The discovered season variation of the efficiency of the magnetic storms influences on the patients with cardio-vascular system diseases must be taken into account in all heliobiological studies. Using different season data in the analysis one can obtain different results (positive or negative) depending of the year season.

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