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Heart attack frequency and geomagnetic field instability (Primates: Hominidae)

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Abstract. It is believed that the high activity of sun with eruptions causing instability of the magnetic field of the Earth cause various health problems in sensitive people, including such events as heart attack. We analysed the daily frequency of patients admitted with heart attack to the Cardiocentre of the Institute of Clinical and Experimental Medicine in relation to daily mean value of the geomagnetic Ap index representing fluctuations in the magnetic field. There were slightly more days with both low Ap and low number of patients than expected by random, and slightly more days with both high Ap and number of patients. However, very high magnetic activity (Ap>30) did not cause high rate of heart attacks.

Key words. Magnetism, alignment, compass, orientation, sensitivity, heart, infarct, cardiac, sun activity, sun wind, aurora borealis.

INTRODUCTION

Magnetic sense of various organisms attracts high attention of researchers. Besides the attempts to explain the anatomy (Němec et al. 2001) and physiology of functioning of the perception of magnetic field (Thalau et al. 2006; mainly light-independent magnetic compass orientation in rodents: Malewski et al. 2018; and light-dependent radical pair mechanism in birds and mammals: Niessner et al. 2016), simple observations of behavioural responses to the field like homing (pigeons: Gagliardo et al. 2009; hunting dogs: Benediktová et al. 2020) show the practical usefulness of the sensing.

Body alignment towards north or south is a common phenomenon that can be easily observed in many taxonomically distant groups of animals (fish: Hart et al. 2012; water birds: Hart et al. 2013a; subterranean rodents: Marhold et al. 2000; foraging foxes: Červený et al. 2011; grazing ruminants: Begall et al. 2008). Such alignment can be disrupted by an external additional extremely low-frequency magnetic field (ELF MF), e.g. under high voltage power lines (Burda et al. 2009). Also, fluctuations or disturbances of the natural geomagnetic field due to the charged particles of solar wind enriched after numerous coronal holes and/or strong eruptions in the sun atmosphere (Coronal Mass Ejection) resulted in disruption of body alignment

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behaviour of urinating dogs (Hart et al. 2013b). Paradoxically, small geomagnetic fluctuations actually improved navigational efficiency of homing pigeons (Jandačka et al. 2022).

It is believed that the activity of sun perceived both as high-energy electrically charged particles (cosmic rays) or mediated through the changes in geomagnetic field (space weather) have direct effects on feeling and health parameters of humans (Mavromichalaki et al. 2012, Galata et al. 2017). Already Tyvin et al. (1995) found correlation between some geophysical factors (geomagnetic activity, atmospheric pressure, temperature and humidity) and child heart rhythm indexes. Subsequently, Gurfinkel & Lubimov (1998) tried to protect patients with ischemic heart disease from geomagnetic disturbances by shielding. A statistically significant link between heart rate variations and specific space weather activities were found in Greece (Galata et al. 2017). Increased geomagnetic activity reduced heart rate variability in Chinese patients with coronary heart diseases (Mao et al. 2022).

While changes in the heart rate measured in selected patients were well-linked to the geomagnetic activity in several cases, the frequency of heart attacks, which can be simply recorded as the number of patients admitted to hospitals, showed contradictory relationships. While Malin & Srivastava (1979) reported significant correlation between daily variations in the geomagnetic activity and daily admissions of patients with cardiac emergencies in several hospitals in India during 1967–1972, Knox et al. (1979) were not able to confirm such relationship in the West Midlands region of United Kingdom during 1969–1970. Thus, we analysed data of admissions of patients to Cardiocentre of the Institute of Clinical and Experimental Medicine during 2017, looking for the relationship of daily frequencies with the daily mean geomagnetic activity.

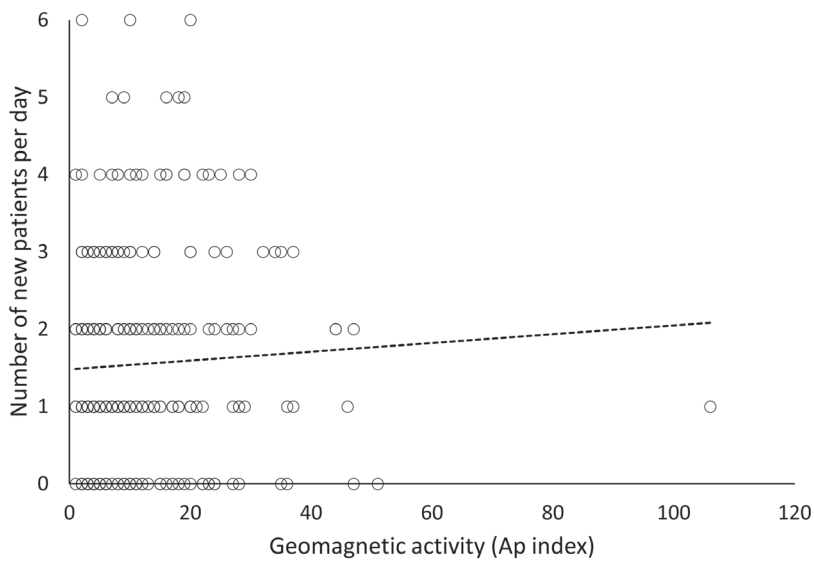

Fig. 1. Number of new patients admitted in IKEM per day is not linearly dependent on the Ap index of geomagnetic activity.

MATERIAL AND METHODS

Patients

We extracted data from the entire year 2017, recorded in the Cardiocentre of the Institute of Clinical and Experimental Medicine (IKEM), Prague, Czech Republic. Each case was represented by the date of receiving (admission) / treating the particular patient. If the same patient was treated in IKEM repeatedly more than seven days after the previous treatment, we included this case as a new, independent one. The following diagnoses were included: I21.0, I21.1, I21.2, I21.3, I21.4, I21.9 (types of myocardial infarction) and I46.0 (cardiac arrest). Thus, we included 562 independent cases out of 1,183 treatments into the study.

Geomagnetic activity

For each day during 2017, eight values of the activity of magnetic field of the Earth was recorded in the Geomagnetic observatory Fuerstenfeldbruck, of Ludwig-Maximilians University, Munich, Germany. Daily Kp values were transformed to linear scale of Ap index (Bartels et al. 1939, Svalgaard 1976).

Statistical analysis

We used a tool available online (http://www.milankabrt.cz/testNezavislosti/final.php) for testing contingency tables, and Excel tool CHIINV for calculation of the probability of the value. Linear correlation coefficient and its probability was calculated in STATISTICA 13 (TIBCO Software, Palo Alto, California, USA).

RESULTS

When the number of patients was plotted against the value of Ap, there was no correlation between the two variables (Fig. 1; p=0.379). The distribution of both variables was highly skewed, as most days had quiet magnetic conditions and low number of newly received patients. If the days were divided to 2×2 contingency table as those with Ap<=15 and Ap>15 and as those with either 0–3 patients or 4–6 patients, the expected and observed numbers of days differed ($G=14.44$, $\chi^2(0.95)=3.84$, $p=1.5\times10^{-4}$). There were slightly more days (278) with both low Ap and low number of patients than expected by random (270), and more days with both high Ap and patients (13 vs. expected 5).

However, very high magnetic activity did not cause very high rate of heart attacks. If the days were divided to 3×2 contingency table as those with Ap≤15, 15<Ap≤30 and Ap>30 and

Table 1. Contingency table with the number of observed / expected days during 2017 with low, high and very high geomagnetic activity and low and high heart attack rate. Proportion obs/exp is represented by grayscale background (darker = relatively more cases observed)

	low (Ap<=15)	high (15<Ap<=30)	very high (Ap>30)
high attack rate (4–6 patients per day)	14 / 22	13 / 4	0 / 1
low attack rate (0–3 patients per day)	278 / 270	45 / 54	15 / 14

as those with either 0–3 patients or 4–6 patients, the expected and observed numbers of days differed ($G=23.18$, $\chi^2(0.95)_{df=2}=5.99$, $p=10^{-5}$). There were slightly more days (278) with both low Ap and low number of patients than expected by random (270), more days with both high Ap and high number of patients (13 vs. expected 4), and no difference between expected and observed number of days with very high Ap index and high number of patients (expected 1 such day, none observed; Table 1).

DISCUSSION

It was demonstrated that geomagnetic activity accounts for temporal heart rate variability in humans and related cardiovascular outcomes (Mao et al. 2022 and references therein). It is believed that geomagnetic storms increase the probability specifically of myocardial infarctions with mechanisms related to such heart rate variability (Halberg et al. 2000). However, such studies that show correlation between the geomagnetic activity and the frequency of heart attack admissions are old and contradictory (Malin & Srivastava 1979, Knox et al. 1979). Here we demonstrate on dataset of 562 cases that the daily numbers of patients admitted with myocadiac infarct and cardiac arrest is higher on days with higher geomagnetic activity.

Because the distributions of both variables are strongly skewed towards low values of activity and low number of patients, the relationship between the two is not significant, and moreover, it is not linear. Thus, we used frequency analysis of contingency table that compares the actual observed number of days with defined range of parameters and expected number of such days if there was no relationship between the two variables. We found that during the days with low geomagnetic activity, there is usually low admission frequency of patients with cardiac diagnosis. During the days with high geomagnetic activity, there are again mostly low numbers of patients but also disproportionally often high admission numbers. This relatively clear pattern was somewhat obscured by the third category, very high geomagnetic activity, that surprisingly did not cause very high admission rates. We thus advocate using contingency tables for analysis of potentially non-linear relationships like this.

There is a three- or four-days delay between the optical observation of high activity of sun and the interaction of charged particles of solar wind with the earth magnetic field (magnetic storm). Thus, astronomical information like that used for the prediction of northern lights (aurora borealis, see e.g. https://www.theaurorazone.com/) can be used for prediction of potential higher rate of heart attacks and thus for preparation of the cardiology departments for an increased number of patients.

Existence of the daily differences in heart attack rate indicates human ability to sense such cues. Halberg et al. (2000) suggested coordinated worldwide systematically aligned biological (human heart-related issues) and physical (geomagnetic activity) monitoring. Only experimental studies can enlighten the mechanism of sensing magnetic field but even the simple descriptive and correlation studies like ours may provide direction for searching the mechanisms of biological interactions of magnetoreception.

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