EFFECT OF BODY TEMPERATURE ON THE ELECRTICAL ACTIVITY OF THE BRAIN IN ANAESTHETISED RATS

VIKTÓRIA NAGY, EDIT PAULIK, ANDRÁS PAPP
Department of Public Health, University of Szeged, Szeged, Hungary

ABSTRACT

The animal experiments with anaesthetise is very widespread in the world. In this stage the sensory function is turned out. During anaesthetise the vegetative thermoregulation is failed; the body temperature is decreased, so it is important that the body temperature of experimental animals is kept around on 37 °C. Using of two narcotics (urethane, ketamine-xilazine) we examined the effect of variable temperature on the central nervous system, as well as the different effect of narcotics in this stage. It was definable that the tail temperature change in different way as the core temperature. This knowledge is important to use in physio- pharmocol-toxicological experiments.

Key words: rat, anaesthesia, thermoregulation, central nervous system activity, peripheral nervous system activity

INTRODUCTION

In animal experiments general anaesthesia evolve a sleeping-like stage caused by the effect of the narcotic on the central nervous system. However, during anaesthesia the vegetative thermoregulation is failed and the body temperature is reduced quickly, particularly in small-sized animals. It leads to alteration of physiological processes and central nervous functions, which is affected by narcotics. Usually, it is established to maintain the temperature of the animals - by any technical way - on 37 °C, which is the normal body temperature in warm-blooded species.

The artificial sleeping causes not only anaesthetised stage but also influence, among others, the thermoregulation, too (Sessler, 1993; Kurz, 2001). During sleeping the temperature decreases, but it remains within the normal range. It is the part of the circadian alteration of body temperature. In anaesthetised stage the agent has influence for several functions of the brain, so it can retard the vegetative system. Thus, the thermoregulation became more imprecise. In waking stage vasomotor refund is started up by the change of core temperature with ±0.2°C, while in anaesthetised stage this refund is started up by ±3°C (Sessler, 1993). In case of small-sized animals the heat loss can be rapid if the body surface is big compared to body weight, therefore it is important to maintain the normal temperature during the whole experiment. (Karwacki et al., 2001). In the course of our experiments we wanted to establish if that the body temperature of experimental animals is changed what alteration is caused on the nervous system recordings particularly on certain electrophysiological parameters. On the other hands we wanted to see weather this effect is depended on the type of narcotics.

MATERIALS AND METHODS

Male Wistar rats were anaesthetised with urethane (1000mg/kg b.w. ip.; Mook, 2006) or ketamine-xilazine compound (100+8 mg/kg b.w. ip.; Farkas et al 1999). The left hemisphere of the anesthetised rats was disclosed and the parietal bone was removed. For recovery from the surgery the animal was put aside for at least 30 min. After that, ball-tipped silver recording electrodes were placed on the dura over the primary somatosensory (SS) area of the whisker pad (barrel field; Tracey and Waite, 1995) and a pair of needle electrodes inserted at the base of tail to deliver electric stimuli, and another pair 50 mm distally to record. SS stimulation was done by electric pulses delivered to the contralateral whisker pad. The regulation of temperature was controlled by the water of the thermostate which held warm the plate. At the beginning of the experiment the temperature was 36.5-37 °C. The core temperature was measured by rectal thermometer about 6 cm from the anus.

One recording session consisted of six minutes recording of ECoG then, evoked potentials (EPs) were recorded from the cortical areas and from the tail nerve, too. One period lasted 20 minutes, after two control record the temperature of the water was reduced to 15 °C by an ice-cube. After three recordings the temperature was increased to 37 °C by thermostate then we recorded 3-4 measurements.

In case of both narcotics 10-10 successful experiences were analysed. The ECoG records were processed by NEUROSYS 1.11 (Experimetria Ltd., Budapest) program. From the ECoG records, the relative spectral power by the standard frequency bands, delta to gamma, (delta, 0,5–4 Hz; theta, 4–7 Hz; alfa, 8–13 Hz; beta1, 13–20 Hz; beta2, 20–30 Hz; gamma, 30–50 Hz; Kandel and Schwartz, 1985) was determined. For characterization of the base activity on the cortex was calculated the ECoG-index (Dési et al, 1998), which is the rate of the slow and the fast waves.

ECoG index = [delta + théta] / [béta1 + béta2]

On the recorded and averaged SS action potentials, latency and peak-to-peak amplitude was measured. The data from the different animals was normalized to the self control data to be comparable.

Statistical analysis was done by two-sample t-test and F-probe.

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The rats were housed under standard conditions (22–24°C; 12-h light:12-h dark cycle with light starting at 06:00 a.m.) with free access to food and water. During the whole study, the principles of the Ethical Committee for the Protection of Animals in Research of the University were strictly followed.

RESULTS

1. Alteration of the temperature during the experience.

The temperature of the animals altered along with the temperature of the water, responded with short delay. The time lag was similar in the phase of the refrigeration and of the warming up. The alteration of the body temperature was for the most part significant. The alteration was bigger in the case of ketamine-xilazine and in general the initial body temperature was lower, too (Fig. 1).

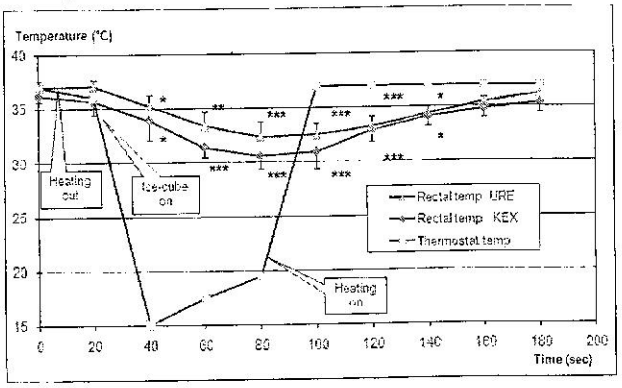
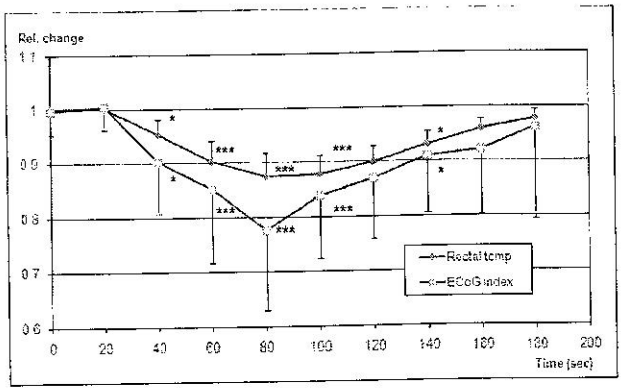


Fig.1. The temporal alteration of the body temperature and the temperature of the water of the thermostate during the experiments. *; **; ***: p<0.05; 0.01; 0.001 vs. control values.

2. The alteration of the body temperature and the electrophysiological parameters, and their coherence in animals anesthetised by urethane

The change of the ECoG's spectral compound followed closely the change of the body temperature. The ECoG index reduced with decreasing temperature, it means that in the base activity on the cortex the relative weight of fast activity increased. It can be seen on Fig. 2. As the left diagram shows, there is high correlation between the temperature and the ECoG index. The high R^2 value shows that the changes of base activity firmly depend on the temperature. The coherence was significant.



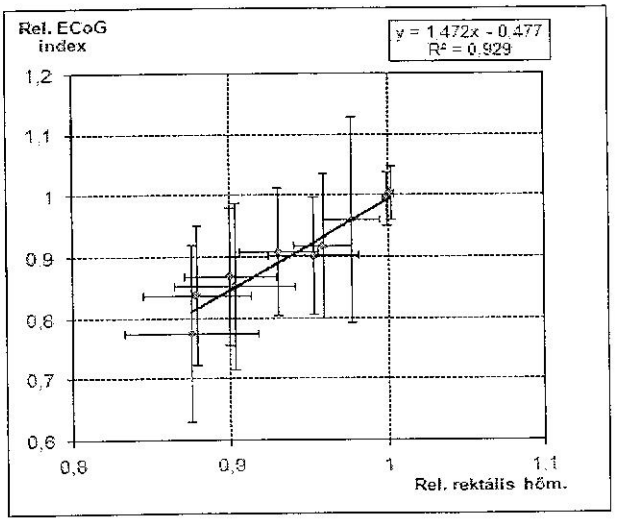
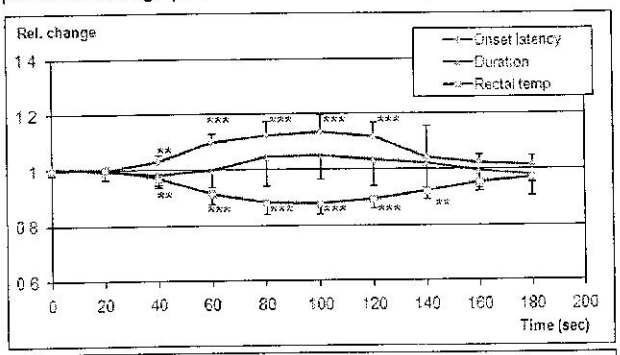


Fig.2. Right: The temporal alteration of the body temperature and ECoG index during the experiments.
*; **; ***: p<0.05; 0.01; 0.001 vs. control values. Left: Correlation diagram, relative change of the temperature and ECoG index.

In the temporal parameters, the onset latency changed the most significantly while the duration did not show unequivocal changes. It can be seen on figure 3 that all parameters of the cortical evoked potentials change parallel with that of the temperature.



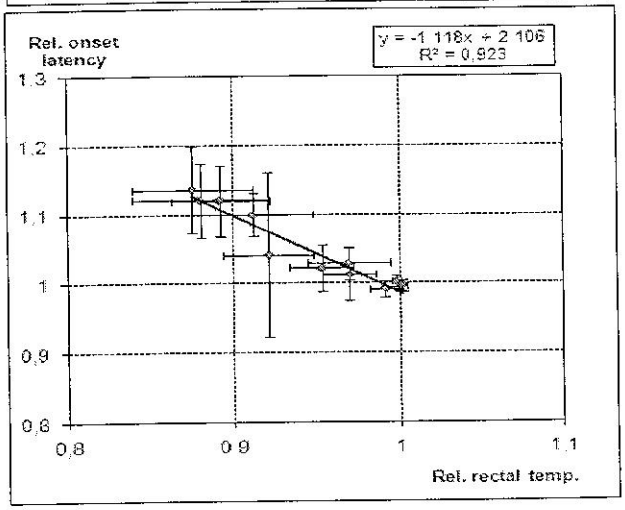
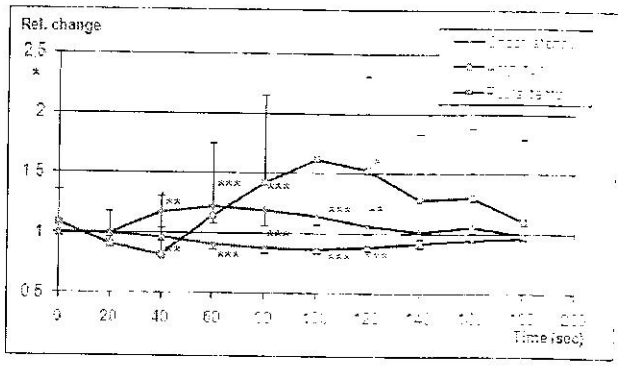


Fig.3. Right: The temporal alteration of the temperature and cortical evoked potential's latency and duration.
*; **; ***: p<0.05; 0.01; 0.001 vs. control values. Left: Correlation diagram, relative change of the temperature and latency.

In case of the tail nerve action potentials also the latency changed the most significantly. The rise of amplitude was less unequivocal which appeared with a short delay. The correlation between latency and rectal temperature was not as strong as in the case of cortical evoked potential. It can mean that the temperature of the tail can change different as the core temperature (Fig. 4).



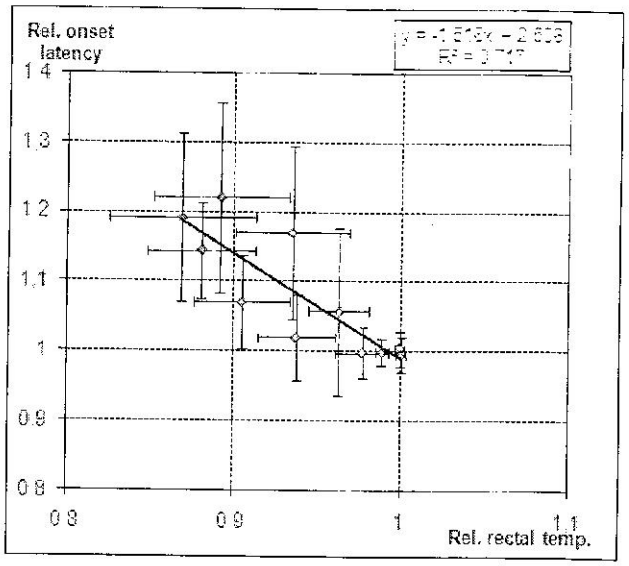
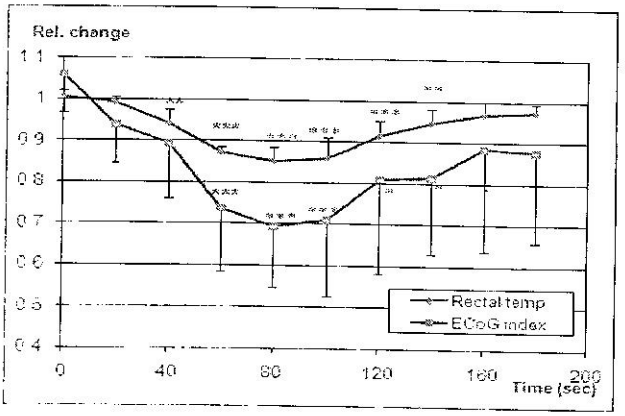


Fig.4. Right: The temporal change of latency and amplitude in the action potential of the tail nerve
*; **; ***: p<0.05; 0.01; 0.001 vs. control values. Left: Correlation diagram, relative change of the temperature and latency.

3. The alteration of the body temperature and the parameters of electrophysiology, and their coherence in animals anesthetised by ketamine-xilazine

The change of ECoG index was similar to that of urethane; however the degree of the alteration was bigger. If the 2nd and the 5th correlation diagram is compared, it can be seen, that the value of gradient is bigger here, which refers to the bigger alteration (Fig. 5).



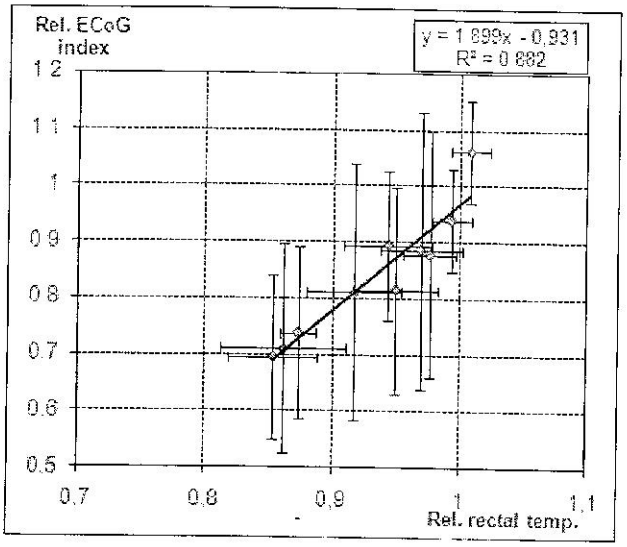
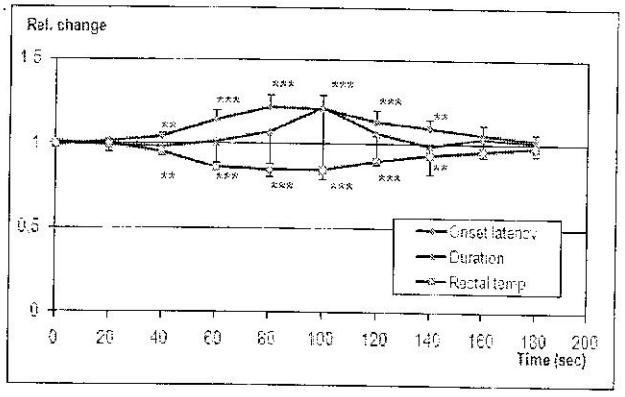


Fig.5. Right: The temporal change of the body temperature and ECoG index during the experiments.
*; **; ***: p<0.05; 0.01; 0.001 vs. control values. Left: Correlation diagram, relative change of the temperature and ECoG index.

Regarding the temporal parameters the alterations were similar as in case of urethane anaesthesia. The onset latency increased significantly, but duration did not show significantly increase (Fig. 6).



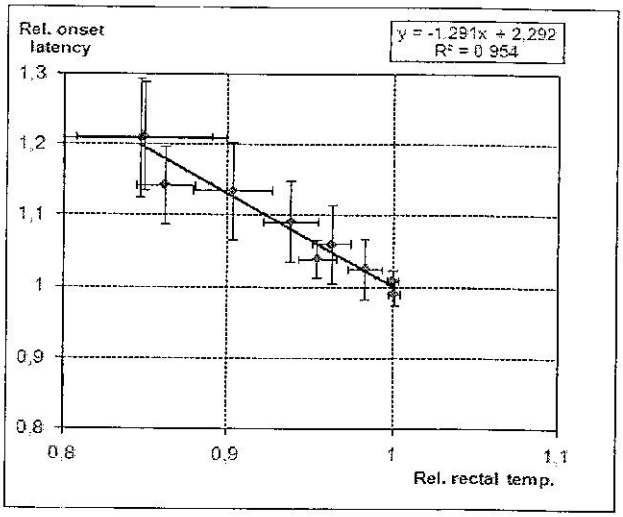


Fig.6. Right: The temporal change of latency and duration in the cortical evoked potential.
*; **; ***: p<0.05; 0.01; 0.001 vs. control values. Left: Correlation diagram, relative change of the temperature and latency.

In case of tail nerve action potential the temperature-dependence of latency was significant. In this case it can be seen too, that the latency of cortical evoked potential and tail nerve action potential showed different coherence with the temperature. R^2 value is bigger here (Fig. 7).

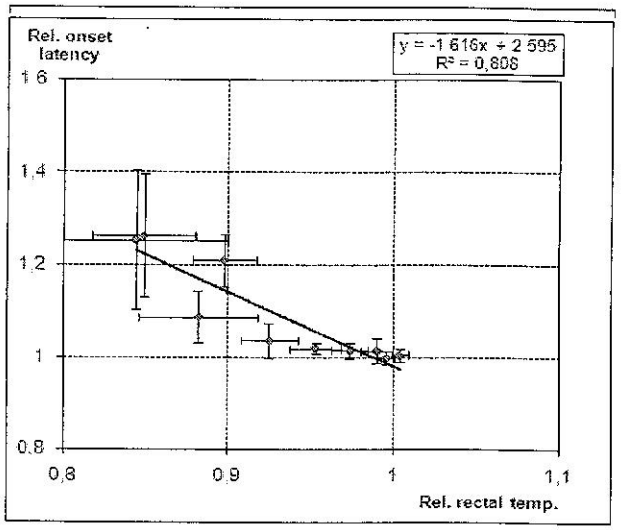
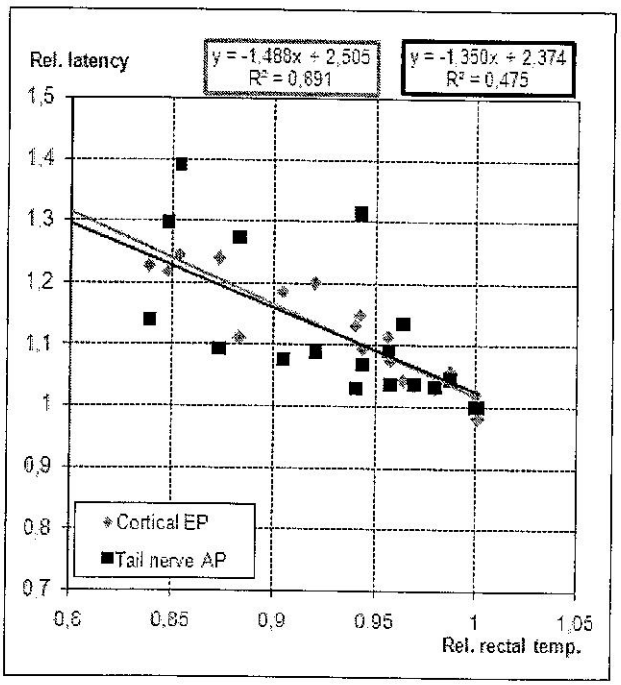


Fig.7. Right: The temporal change of latency and amplitude in the action potential of the tail nerve, KEX anaesthesia. *; **; ***: p<0.05; 0.01; 0.001 vs. control values. Left: Correlation diagram, relative change of the temperature and latency.

4. Conformation of the temperature on the cortex and on the tail and its effect of the evoked potentials

The abdominal temperature reacted for the refrigeration and warming up with delay, as it can be seen on Figure 1. The tail consorts with the big surface of the plate, so the temperature of the tail can be different from the body temperature. However, we did not measure the own temperature of the tail, but we



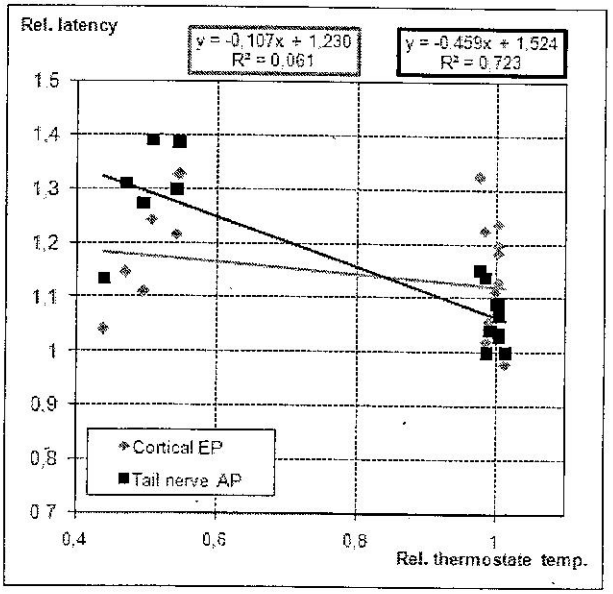


Fig.8. Right: Coherence of latency's cortical evoked potential and tail nerve action potential with body temperature. Left: Coherence of latency's cortical evoked potential and tail nerve action potential with thermostat temperature.

CONCLUSION

According to our results it can be concluded, that slight decrease in the temperature of an anaesthetised rat – the level of anaesthesia that does not cause irreversible damage – can significantly alter the measurable parameters of central or peripheral nervous activity. Along with findings of our laboratory, it can be stated, that these functional nervous system alterations are comparable in magnitude with those gained by xenobiotic exposure.

Thermoregulation differently extends to different parts of the body even if non-anaesthetised, pharmacologically non-exposed animals. Investigating the tail, results show that

temperature of the tail changes independently from the other parts of the body in response to heating-cooling the holding plate. This can be of importance when examining tail nerve activity (or of other peripheral parts) and if the body temperature is stabilized.

To summarize it can be said that in experimental studies it is essential to know, to monitor and to stabilize the temperature of the animals, in order to reveal every disturbing factors of animal experiments to achieve more precise and explainable results reflecting only the effects of the xenobiotics.

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EFECTELE TEMPERATURII CORPORALE ASUPRA ACTIVITATII ELECTRICE CEREBRALE LA SOBOLANII ANESTEZIATI

REZUMAT

Experimentele animale care implica anestezia sunt foart larg raspandite in lume. In acest stadiu, functia senzoriala este intrerupta. In timpul anesteziei, termoregalrea vegetativa este ineficienta; temperature corpului scade, astfel incat este important ca temperatura corpului la animalele experimentale sa fie mentinuta in jurul valorii de 37 °C. Utilizand doua substante narcotice (uretan, ketamina-xilazina), am examinat efectul variatiei temperaturii asupra sistemului nervos central, precum si efectul narcoticelor in acest stadiu. A fost demonstrat ca temperatura la nivelul cozii variaza diferit comparativ cu temperatura la nivel central. Aceasta observatie este importanta pentru a putea fi folosita in experimentele psiho-farmaco-toxicologice.

Cuvinte cheie: sobolan, anestezie, termoreglare, sistem nervos central, activitatele sistemului nervos periferic