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SHORT COMMUNICATION

CHANGES IN HYPOTHALAMIC AND BODY TEMPERATURES DURING 24 HOURS IN RATS

MAHESH KUMAR KAUSHIK[1], HRUDA NANDA MALLICK[1]* AND VELAYUDHAN MOHAN KUMAR[1]**

**Department of Physiology,*
All India Institute of Medical Sciences,
Ansari Nagar, New Delhi – 110 029

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Abstract : The available information on simultaneous assessment of body and hypothalamic temperatures in rats are lacking. In the present study these temperatures were recorded for 24 h, on three alternate days, in rats maintained at an ambient temperature of 26±1°C. Hypothalamic temperature was significantly higher than body temperature during the night. In nocturnal rats the magnitude of circadian variation in hypothalamic temperature was higher than body temperature. Though maintained at different levels, both the temperatures showed closely associated diurnal changes throughout the 24 h period.

Key words : diurnal; circadian; hypothalamic temperature; body temperature

INTRODUCTION

Measurement of body temperature is one of the most important parameters in clinical practice and experimental studies. Body temperature shows circadian variation in rats, as found in most of the mammals (1). Brain temperature, especially near the thermoregulatory area, represents the best site for measurement of deep body temperature (2). Temperature measurements from rectum, pulmonary artery, bladder, esophagus, peritoneum and tympanum are used as surrogates of brain temperature. There are several reports regarding brain temperature being higher than in the rest of the body (2). The hypothalamic temperature and colonic temperature show parallel circadian variations in the squirrel monkey (3). It has been reported that the hypothalamic temperature was regulated over a narrow range as compared to colonic temperature (3). Although the laboratory rats have been extensively used as experimental

*Corresponding Author : Dr. H.N. Mallick, Professor, Department of Physiology, All India Institute of Medical Sciences, New Delhi – 110 029; Email : drhmallick@yahoo.com; Tel.: +91-11-26594881; Fax : +91-11-26588663

**Present Address : Department of Neurology, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum – 695 011

animal, reports on simultaneous continuous monitoring of body and brain temperatures during 24 h light-dark cycles are limited. Rats maintained at 12 h light and 12 h dark cycle had higher peritoneal and cortical temperature at night as compared to day (4). According to this report, the cortical temperature was lower than the peritoneal temperature, but the difference between the two temperatures was maintained during day and night. Rats maintained at constant illumination also showed simultaneous changes in hypothalamic and peritoneal temperature during the 24 h recording period (5). The present study was undertaken to find out the extent of variation in hypothalamic and body temperature in rats during 24 h when maintained at 14 h light and 10 h dark cycle with thermoneutral temperature.

MATERIAL AND METHODS

Ten adult male Wistar rats weighing between 200–250 g, obtained from the experimental animal facility of All India Institute of Medical Sciences, New Delhi, India, were used in the study. All experimental procedures were approved by Animal Ethics Committee of All India Institute of Medical Sciences, New Delhi. Experimental rats were kept in individual cages with 14 h light (illumination above 200 lx) and 10 h dark (illumination below 5 lx) at the ambient temperature of 26±1°C, which is the thermoneutral temperature for rats (6). Food and water were provided ad libitum. Under sodium pentobarbital (40 mg/kg body weight, i.p.) anesthesia, the rats were implanted with radio transmitter (Data Sciences USA, TA10TA-F40 7.5 gm and 3 × 1.3 × 0.8 mm) intra-peritoneally, for the assessment of body temperature telemetrically. A pre-calibrated thermocouple (K-type, chromal-alumel) was lowered along the midline at an angle of 25°. In order to avoid damage to the brain, the thermocouple was introduced between the dura and subarachnoid, to a height of 4.5 mm at A 9.0 mm as per DeGroot atlas, for the assessment of hypothalamic temperature near the preoptic area (7). The other end of the thermocouple was fixed to the skull with dental cement. Hypothalamic temperature was recorded by connecting the thermocouple with Fluke Multimeter (FLUKE 189 True RMS Multimeter), which feed data continuously to computer, on desired time interval.

After recovery from postoperative trauma (i.e. seven days after surgery), animals were placed in the recording chamber, maintained at 26±1°C with connected cables for habituation for at least 24 h. Rats were placed in recording chamber, with the connected wires, at least one hour prior to the study. Simultaneous recordings of body temperature and hypothalamic temperature were started at 20.00 h (onset of dark period) and continued for 24 h. Each animal underwent three similar recordings on alternate days. The data for body temperature and hypothalamic temperature were acquired in 5-second epochs continuously. Later 5-second data were clubbed to 30-min for the purpose of analysis. Body temperature and hypothalamic temperature recording devices were calibrated before implantation and after the sacrificing the animals.

Statistical analysis was performed using STATA software (Data Analysis and

Statistical Software). A total of 49 time points (including the beginning and end point data) of body temperature and hypothalamic temperature, within 24 h, were taken for statistical analysis. Difference between Body temperature and hypothalamic temperature during day and night were found out by paired t-test. Individual means of day and night for body temperature and hypothalamic temperature were calculated and compared to find out the degree of dissociation. Intra class correlation was calculated to find out Correlation coefficient (r), between body temperature and hypothalamic temperature, to find out whether or not, body temperature and hypothalamic temperature follow simultaneous and similar changes during light/dark cycle.

RESULTS AND DISCUSSION

During night hypothalamic temperature (37.91±0.23°C) remained significantly higher ($P<0.03$) than body temperature (37.76±0.19°C). Hypothalamic temperature and body temperature (37.04±0.33°C and 37.01±0.21°C, respectively) did not show any significant difference during the day. Both hypothalamic temperature and body temperature showed similar diurnal variations and changes throughout 24 h (Fig. 1), and good correlation during day ($r=0.969$, $P<0.001$) as well as during night ($r=0.890$, $P<0.001$) (Fig. 2). The 24 h mean hypothalamic temperature (37.4±0.28°C) is higher than body temperature (37.31±0.14°C). Though hypothalamic temperature and body

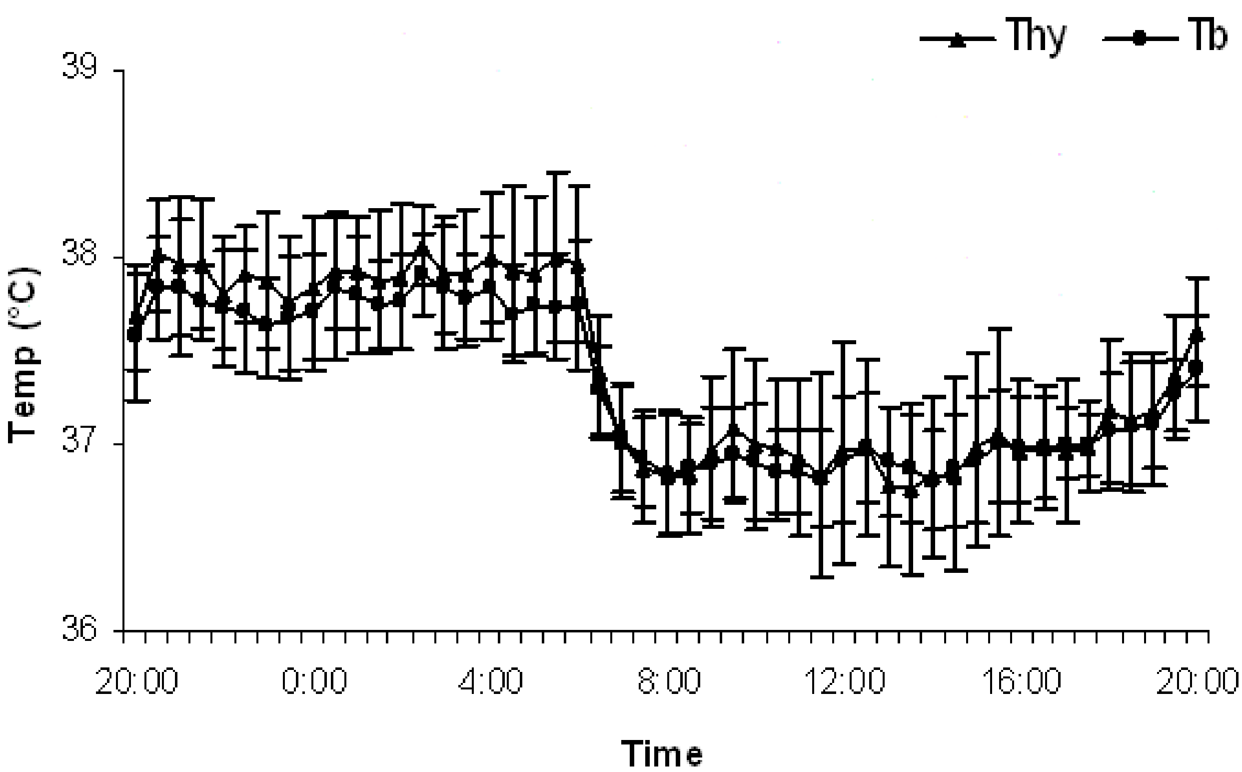

Fig. 1 : Time course of hypothalamic temperature (Thy) and body temperature (Tb) during 24 h cycle (10 h dark/14 h light). Each point represents the mean of all temperatures recorded during every 30 min. 20:00 h in the graph represent the onset of dark period. Data are expressed as means±SD (n=10).

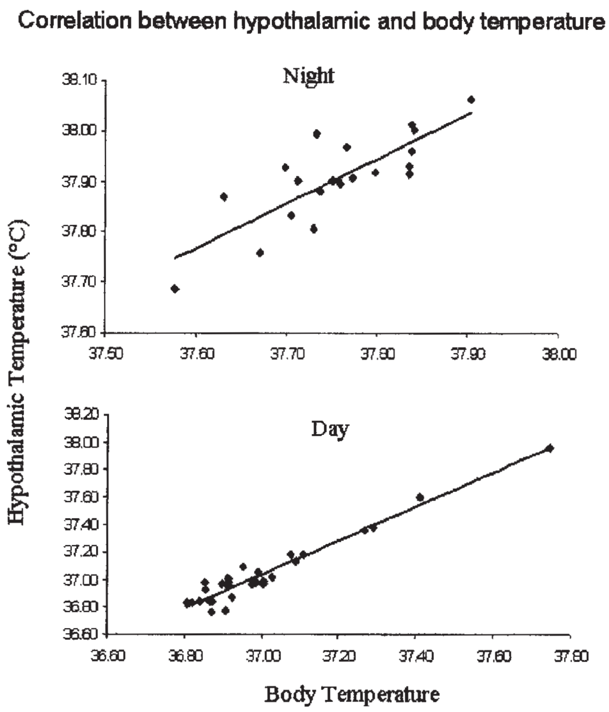

Fig. 2 : Correlation between hypothalamic temperature and body temperature in rats (n=10) during night and day.

temperature showed simultaneous changes, hypothalamic temperature had more diurnal variation in comparison to body temperature, as evident from day-night differences of the temperature i.e. 0.86±0.20°C (hypothalamic temperature) and 0.75±0.17°C (body temperature). On transition from dark phase to light phase there was sharp decrease in both hypothalamic temperature and body temperature. Opposite trend was observed during transition from light period to dark period.

Significant difference in day/night values for both hypothalamic temperature and body temperature ($P<0.001$) was indicative of the circadian rhythms of these two parameters (Fig. 1). High locomotor activity, less sleep and high metabolic heat production would be contributing towards higher temperature at night in the nocturnal rats (8). But the day/night difference in temperatures can be primarily attributed to circadian influence as rest-activity cycle alone is not sufficient to modulate the body temperature (6). Circadian rhythms has been reported to persist in subjects whose rest-activity cycle was disturbed (9).

The hypothalamic temperature was higher than the Body temperature as was shown in some of the previous studies (2, 3, 5). The brain temperature can be regulated differentially from body temperature (4, 8). High metabolic heat production in the brain might account for higher hypothalamic temperature as compared to core body temperature. Lower hypothalamic temperature during the day was responsible for lesser difference in hypothalamic temperature and body temperature at this period. Lower hypothalamic temperature during the day could be attributed to predominance of sleep episodes during this period in the nocturnal rats, as regulation of brain temperature is less effective during the sleep (10). However in squirrel monkey hypothalamic temperature remained higher than colonic temperature throughout the 24 cycle (3). This variation could be attributed to the difference in species. But parallel changes in body temperature and hypothalamic temperature were observed in the present study also. There was a close association between the waveform and phase of the hypothalamic temperature and body temperature.

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