学術フロンティア公開シンポジウム抄録

Difference in thermoregulation between male and female

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It is well known that circadian change in body temperature is different between male and female: that in female is closely linked with the menstruation cycle. During estrus period, body temperature in the active phase goes up, and that during proestrus period goes down. However, the mechanism remains unclear. We hypothesized that change in the blood level of sex hormones, especially estrogen, would be closely involved in thermoregulation. To test the hypothesis, (i) daily change of body temperature and (ii) thermoregulatory responses in the heat or cold in rats were assessed in the present study. Fist, we measured daily changes in body temperature by biotelemetry, metabolism by indirect calorimetry, and body surface temperature by thermography after gonadectomy in male and female rats (n=6 each) under 12:12h light-dark condition. Compared with normal rats, body temperature in the female gonadectomized rats became unstable, showing 2–4 h irregular small oscillations, although chi-square analysis indicated that the period of the rhythm remained 24 h. There was no change in the Tb rhythm in the male gonadectomized rats, compared with normal rats. There was a close relationship between body temperature and metabolism in the gonadectomized female rats, which was similar in both the daytime and nighttime. In contrast, the relationship was different between the daytime and nighttime in the male gonadectomized rats. In addition, body surface temperature in the gonadectomized female rats was lower than that in the male rats. Second, to evaluate the effect of estrogen on the circadian change of body temperature, two silicon tubes containing 17-beta estradiol (E_2) crystalline were subcutaneously implanted in the gonadectomized rats. In the female gonadectomized rats with the E_2 tubes, the Tb rhythm was restored to the normal pattern. However, there was no influence of E_2 on the T_b rhythm in the male rats. Gonadectomy affected metabolism and body surface temperature in female rats, however, the E_2 tubes restored the two parameters to those in the male rats. These results indicate that E_2 is necessary in the thermoregulation for daily change of Tb in female rats, but not in male rats. During 2-h heat exposure at 34℃, gonadectomized female rats could not maintain their body temperature, which went over 41℃. In contrast, gonadectomized female rats with E_2 tubes could maintain their body temperature below 39℃. Two-hour cold exposure at 5℃ induced a reduction of body temperature in gonadectomized female rats; however, those with the E_2 tubes showed an increase in body temperature. Metabolism was greater in gonadectomized rats with E_2 tubes than those without E_2 tubes during the cold exposure. These results indicate that estrogen may be also necessary for thermoregulation in the heat and cold. In addition, neural activity estimated by Fos immunoreactive cells in the hypothalamus was smaller in the gonadectomized rats without E_2 tubes. This may indicate that thermosensitivity in the area is involved in the attenuation of thermoregulatory responses.

In summary, estrogen may be involved in thermoregulation for daily change in body temperature and in hot and cold environments. Although the mechanism remains unclear yet, we speculate that estrogen affect the thermoregulatory system at the level of the central with sex difference.