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Endocrinology & Metabolic Syndrome

Commentary

Thermoregulatory Hormones: Endocrinology of Body Temperature Regulation

Qiang Tan*

Department of Endocrinology, New York University Grossman School of Medicine, New York, USA

DESCRIPTION

Thermal regulation, also known as thermoregulation, is the physiological process by which organisms maintain their core body temperature within a narrow range, despite fluctuations in external environmental temperatures. This intricate process is major for the survival and optimal functioning of all living organisms. In mammals, including humans, the endocrine system plays a fundamental role in controlling thermal regulation through hormone-mediated responses. In this article, we will explore the endocrinology of thermal regulation and the key hormones involved in maintaining thermal homeostasis.

Hypothalamus

The hypothalamus, a small region at the base of the brain, serves as the primary control center for thermoregulation. Within the hypothalamus, there are specialized nuclei that detect changes in core body temperature and initiate appropriate responses to maintain thermal homeostasis. These nuclei receive input from peripheral thermoreceptors located in the skin, as well as from internal thermoreceptors within the body.

Hormonal regulation of thermoregulation

Several hormones are involved in the regulation of thermal balance, and they act on various target tissues to modulate heat production and heat dissipation. Here are some of the key hormones involved in thermoregulation:

Thyroid hormone: Thyroid hormones play a major role in setting the basal metabolic rate, which influences heat production. When thyroid hormone levels are low (hypothyroidism), BMR decreases, and individuals may feel cold and have difficulty maintaining body temperature. Conversely, elevated thyroid hormone levels (hyperthyroidism) can lead to excessive heat production and intolerance to heat.

Adrenal hormones: The adrenal medulla produces epinephrine and norepinephrine, which are released in response to stress or cold exposure. These hormones trigger various responses, including increased heart rate and vasoconstriction, to conserve heat and maintain blood pressure during cold exposure.

Cortisol: The adrenal cortex produces cortisol, which has anti-inflammatory and immunosuppressive effects. In response to stressors like illness or injury, cortisol can influence the body's thermoregulatory mechanisms. Chronic elevations in cortisol levels can impact thermoregulation, potentially leading to changes in body temperature.

Insulin: Insulin, produced by the pancreas, regulates glucose metabolism. When blood glucose levels are low, as can occur during fasting or excessive cold exposure, insulin secretion decreases. This can reduce glucose utilization by cells, thereby conserving energy and heat.

Growth hormone: GH, produced by the anterior pituitary gland, has a role in regulating growth, metabolism, and body composition. GH can influence energy expenditure and the utilization of fat for heat production.

Vasopressin: Vasopressin, released by the posterior pituitary gland, plays a role in water reabsorption by the kidneys. It can influence blood volume and, indirectly, thermal regulation by affecting blood flow to the skin.

Leptin: Leptin, produced by adipose (fat) tissue, plays a role in regulating appetite and energy balance. It can also influence thermoregulation by modulating sympathetic nervous system activity and energy expenditure.

Cytokines: Inflammatory cytokines, such as interleukin-1 and tumor necrosis factor-alpha, can influence thermoregulation by acting on the hypothalamus. These cytokines are released in response to infection or inflammation and can lead to fever, an adaptive response to help combat pathogens.

Melatonin: Melatonin, produced by the pineal gland in response to changes in light-dark cycles, plays a role in the regulation of circadian rhythms. It can also influence body temperature, with core body temperature typically decreasing during the night.

Disorders affecting endocrine-mediated thermoregulation

Various medical conditions can disrupt the hormonal regulation of thermal balance:

Correspondence to: Qiang Tan, Department of Endocrinology, New York University Grossman School of Medicine, New York, USA, E-mail: qiang@hdu.edu

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Hypothyroidism: An underactive thyroid gland can lead to decreased heat production and cold intolerance.

Hyperthyroidism: An overactive thyroid gland can result in excessive heat production and heat intolerance.

Adrenal disorders: Conditions like Addison's disease (adrenal insufficiency) or Cushing's syndrome (excessive cortisol production) can affect thermoregulation.

Diabetes: Poorly controlled diabetes can lead to blood sugar fluctuations, affecting thermoregulatory mechanisms.

Obesity: Excess body fat can alter the hormonal regulation of heat production and dissipation.

Fever: Infections and inflammatory conditions can trigger fever, which involves an elevation in the body's set point for temperature regulation.

CONCLUSION

In conclusion, the endocrinology of thermal regulation is a sophisticated system that meticulously maintains the body's temperature within a narrow range. The intricate interplay of hormones, particularly orchestrated by the hypothalamus, underscores the adaptability of the human body to diverse thermal challenges. This hormonal symphony involves not only core players like thyroid hormones but also the nuanced contributions of various endocrine pathways in modulating metabolic responses, vasomotor activity, and perspiration.