The Physiological Role Of Cortisol In Response To Stress And Immunity In The Body: A Review

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ABSTRACT

There are different functions of cortisol in the human body as ~~lowering~~ raising blood sugar, immunity suppress with response to stress, role in the metabolism and synthesis of proteins. It is generated and released through serial hormonal cycles of Pituitary-hypothalamus-Adreno corticao thyrotropic hormone and released from adrenal cortex into the blood to perform various physiological, pathological, and chemical functions as long as human body needed.

Keywords: cortisol, Interleukin, HPA, SNS

ADRENAL CORTEX HORMONE (CORTISOL)

It is a hormonal steroid that goes to the glucocorticoid hormone family. "Hydrocortisone" is the a drug ~~term~~ given and administered as a ~~remedy~~treatment. It is generated in "the zona fasciculata of the adrenal cortex of the adrenal gland" in numerous mammals (1). It is synthesized in other tissues in lower amounts and has a diurnal cycle, and is produced more often in response to stress and hypoglycemia. It rises the blood sugar levels through the metabolic operation (e.g. gluconeogenesis), and

reduces the immune system function, accelerate metabolism of fat, protein, and carbohydrate, and suppress bone formation (2, 3). The chemical formula of cortisol is C21H30O5 (4) (See Figure 1).

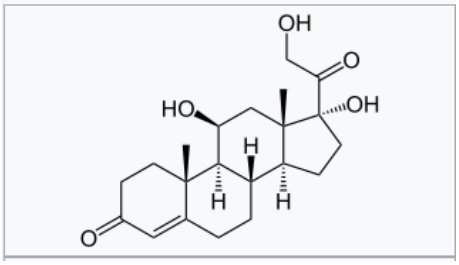

Figure 1: Chemical construction of cortisol (4).

STRESS

Anybody organism's reaction and/ or responses to a stressor, such as an environmental conditions (5). Stress is the body's reaction to a situation that includes a threat, a challenge, or a physical or psychological barrier. In our body, "multiple systems respond to stimuli that change an organism's surroundings" (6). The two principal systems included System of Autonomic Nervous and the hypothalamic-pituitary-adrenal considered as axis which are respond to the situational stress in humans and most animals (7) (See Figure 2).

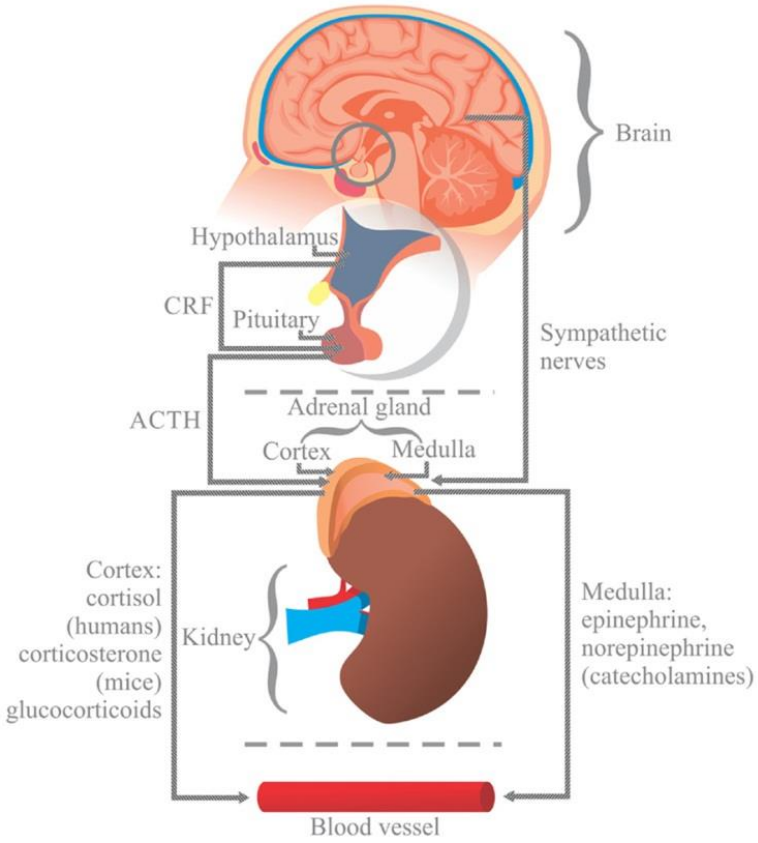

Figure 2: The hypothalamus - ACTH - adrenal cortex of the adrenal gland axis with the responding of the stress (8).

RESPONDING TO STRESS

The two branches of the System of Autonomic Nervous including system of parasympathetic nervous and system of sympathetic nervous are topically active and have opposing actions. The preganglionic neurons initiating in the intermadiolateral cell column, where it control postganglionic nerves directly via innervate tissue. The medulla, midbrain, hypothalamus, prefrontal cortex, limbic system, and monoamine nuclei all provide signals to the ANS (9).

The phenomenon "fight or flight" reaction is triggered by The SNS. So, mydriasis, Tachycardia and force contraction, dilatation of bronchi, vasoconstriction, glycogenolysis, gluconeogenesis, sweating, lipolysis, decreased digestive movement, adrenal medulla secretion of epinephrine and cortisol, and bladder wall relaxation are all part of the fight or flight response to an stress or emergency. The parasympathetic nervous system's "relax and digest" reaction encompasses miosis, bronchoconstriction, increased digestive activity, and bladder wall contractions in order to restore to equilibrium (10). ANS related the physiological mechanisms of the ANS are thought have major role in increasing the risk of cardiovascular disorders after major stressful events (11). When ACTH is secreted into the bloodstream, it binds to and activates the Melanocortin receptor, which induces the production of steroid hormones, and the last bind with glucocorticoid receptors in the brain, decreasing ACTH release and delivering negative feedback. Some research suggests that a second long-standing response mechanism exists that is unaffected by cortisol excretion. The hypothalamus gets signals from the solitary tract nucleus and the lamina terminalis. It gets and responds to modifications in blood pressure through these inputs response to stress (12).

Both systems ; system of sympathetic nervous and system of parasympathetic nervous are two branches of the autonomic nervous system that are tonically active and have opposing actions. The postganglionic nerves, which are regulated by preganglionic neurons initiating in the intermediolateral cell column, directly innervate tissue. The medulla, hypothalamus, limbic system, prefrontal cortex, midbrain, and monoamine nuclei all provide signals to the system of sympathetic nervous (9).

The system of sympathetic nervous is responsible for what is known as the "fight or flight" reaction. Mydriasis, Tachycardia and force contraction, dilatation of bronchi,

vasoconstriction, glycogenolysis, gluconeogenesis, sweating, lipolysis, decreased digestive movement, adrenal medulla secretion of epinephrine and cortisol, and bladder wall relaxation are all part of the fight or flight response to an stress or emergency. The parasympathetic nervous system's "relax and digest" reaction encompasses miosis, bronchoconstriction, increased digestive activity, and bladder wall contractions in order to restore equilibrium (10). There are complicated interactions between vulnerability and protective factors on the influence of child period of house stress on cardiovascular abnormality, psychological disorders, and adaption. related mechanisms are believed to contribute to an improved risk of cardiovascular abnormality after most important events of stress (11). When ACTH is secreted into the bloodstream, it binds to and activates the melanocortin receptor, which induces the production of steroid hormones. In the brain, steroid hormones connect to receptors of glucocorticoid, decreasing ACTH release and delivering negative feedback. Some research suggests that a second long-standing response mechanism exists that is unaffected by cortisol excretion. The the paraventricular nucleus of the hypothalamus gets signals from the lamina terminalis and the solitary tract nucleus. It receives and responds to changes in blood pressure through these inputs (12).

IMMUNITY REACTION

Cortisol inhibits the inflammatory chemicals discharging in the body.therefore it is used to treat diseases caused by an overexcited B lymphocyte-mediated antibodies responses, for example the Inflammatory and rheumatoid disorders, and allergies reactions. Skin disturbances signs such as rashes and eczema are cured via topical hydrocortisone with low-dose, but it is considered as a nonprescription drug in numerous countries.

"Cortisol" prevents production of interleukin 12 (IL-12), interferon type gamma, interferon type alpha, and tumor necrosis factor type alpha, Th2 cells upregulate IL-4, interleukin 10, and IL- 13 from the macrophages and T lymphocyte cells (type Th1). So that, rather than widespread immunosuppression, a Th2 immune response are elicited., therefore during an infection, the activation of the stress system (and following rising in cortisol and Th2 shift) is a defensive mechanism that avoids an over-initiation of the inflammatory responding (13). Cortisol can make the less effective immunity via inhibits proliferation of T lymphocytes , making IL-2 insensitive to IL-1 as well as unable to create the T-cell growth factor, "suppresses the expression of IL-2R on the surface of the T lymphocytes, which is requisite to originate a Th1 'cellular' immune

response, preferring a shift to Th2 dominance and the release of the interleukins listed above, resulting in Th2 dominance and the 'humoral' B lymphocyte-mediated antibodies responses, so that the Cortisol has a negative response impact on interleukin-1 (IL-1**)** (14). Endotoxic bacteria have compelling the hypothalamus to elevate cortisol levels, with the fact that IL-1 are valuable in the treatment of several disorders (forcing the secretion of corticotropin-releasing hormone, thus antagonizing Interleukin 1). Glucosteroid response-modifying factor has no effect on suppressor cells (15). As a result, the effective set-point for lymphocytes may be much greater than the physiological setpoint (reflecting lymphocytes redistribution to lymph nodes, skin and bone marrow). Adrenalinectomized rats were given corticosterone (an endogenous type I and an endogenous type II receptor agonist) or (a selective type II receptor agonist)" and their leukocyte distribution was altered. Cortisol has an effect on natural killer cells (16). Many copper enzymes, notably lysyl oxidase, which cross-links collagen and elastin, are stimulated by cortisol (typically to 50% of their entire capacity). Cortisol's activation of superoxide dismutase is especially important for immunological response (17), because the body probably definitely uses this copper enzyme to allow superoxides to harm microorganisms (18) (See figure 3).

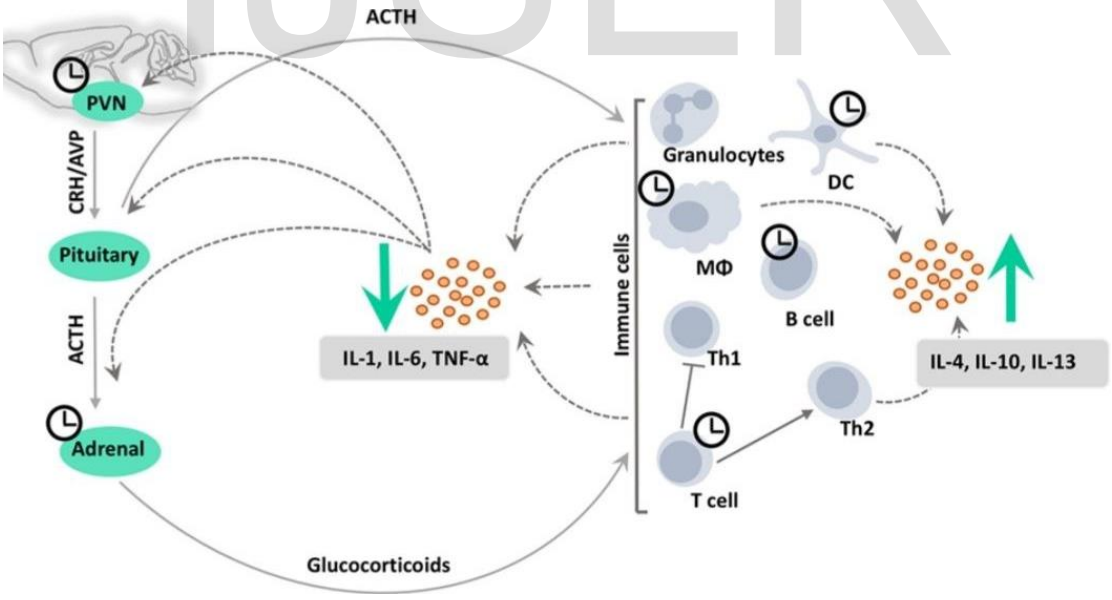

Figure 3: Response of cortisol to immunity Immune cells can stimulate the production of glucocorticoids by activating the HPA axis via cytokines such as tumor necrosis factor type alpha , interleukins 1 and interleukins 6 at the paraventricular nucleus (PVN) of the hypothalamus, as well as the pituitary and adrenal glands. To defeat the induction of pro-inflammatory reactions, and to stimulate a shift from (Th1type) toward (Th2 type)-mediated humoral immune response, glucocorticoids action on the receptors on

the cell membrane or in the cytoplasm of lymphocytes. This inhibits the creation of "pro-inflammatory Interleukins, while promoting the creation of anti-inflammatory Interleukins, such as IL-13, IL-10, and/or IL-4 by various lymphocytes. In addition, ACTH uses immune-modulating effects and direct anti-inflammatory via the system's melanocortin. CRH stands for DC stands for dendritic cell; corticotropin-releasing hormone; AVP stands for arginine vasopressin" and M stands for macrophage (19).

THE IMMUNITY AND STRESS

"Stress" may have a significant impact on the immune system. The sympathetic nervous system regulates immune function by innervating numerous immunological tissues (e.g. spleen bone marrow). The sympathetic nervous system's adrenergic chemicals may attach to and impact diverse immune cells, creating another link between them. The HPA axis eventually leads to the production of cortisol, which has immunosuppressive properties. On the other hand, the influencing of the stress on the immunity is debatable and numerous simulations have been presented in a try to explanation for both "immunodeficiency"-related disorders and disorders requiring immune system hyper activation. One concept developed to explain this argues that cellular immunity is being pushed to an unbalanced state (Th1) and humoral immunity (Th2) (20). Hyperactivity of the Th2 system was thought to be the cause of various kinds of immunological hypersensitivity, as well as an increase in the risk of disorders linked to a weakened immune system, such as infection and cancer (20).

CONCLUSIONS

Cortisol is steroid hormone and generated in the body as response as needing with different in physiological, pathological and biochemical disorders that occured due to internal or external varying factors. Therefore, cortisol has different advantage roles and correlation with the health effects in the body.

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