

Stress, Thyroid Hormone Secretion and Vestibular Stimulation: A Review of the Links

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ABSTRACT

Stress is part and parcel of our daily life. It is defined as a state of disharmony or threatened homeostasis. Stress can specifically influence several systems. Here we review the interactions of stress and thyroid hormone secretion and vestibular stimulation to suggest necessary translational research in this area. Vestibular stimulation may be used as a supplemental therapy for thyroid disorders. We suggest detailed studies in this area to explore importance of vestibular stimulation in the management of thyroid disorders.

Key words: Stress, Vestibular stimulation, Translational Research, Thyroid

secretion, Homeostasis.

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INTRODUCTION

Stress is part and parcel of our daily life. It is defined as a state of disharmony or threatened homeostasis. The concept of stress and homeostasis can be traced back to ancient Greek history, however, the integration of these notions with related physiologic and pathophysiological mechanism and their association with specific illnesses is much more recent. Stress at work is a relatively new phenomenon of modern lifestyles. It covers all professions, starting from a daily wages employ to employer, artist to a surgeon, patient to hospital staff. Any change in the environment demands some coping; and little stress helps us adapt. But, beyond some point, stress becomes distress basically individual's response to fight/flight a situation. Stress when pathological, causes lot of physical and mental health problems.¹ Stress causes physiological, biochemical and behavioral changes in our body it cause generalized, non-specific response to any factor that overwhelms or threatens to overwhelm, the body's compensatory abilities to maintain homeostasis.^{2,3} Here we review the interactions of stress and thyroid hormone secretion and vestibular stimulation to suggest necessary translational research in this area.

MATERIALS AND METHODS

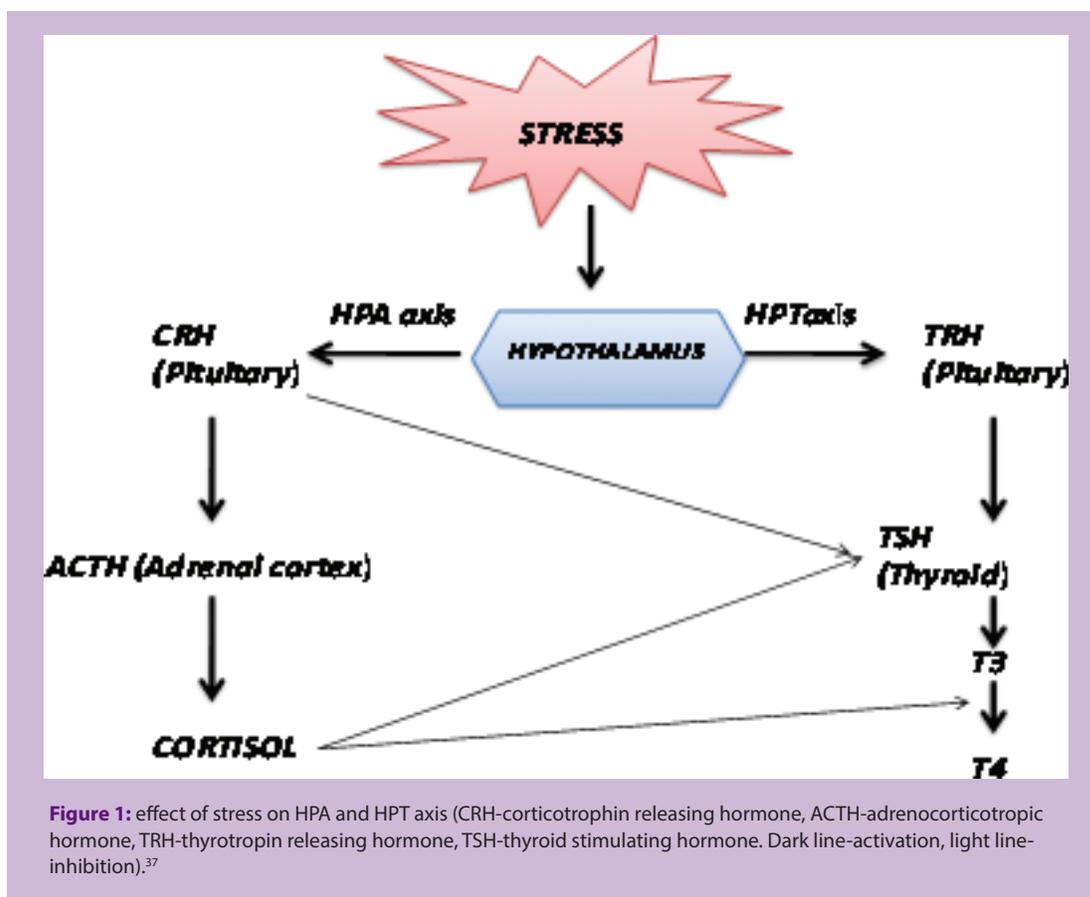
A detailed review of published literature from google, pubmed, British Medical Journals, Hindawi, Frontiers, Dove Press, ERIC and other online journals was performed and analyzed.

Interactions of stress and Thyroid hormone secretion

Stress modulates secretion of hormones and may lead to endocrine disorders. Stress increases secretion of Glucocorticoids, growth hormone, prolactin and catecholamines. Stress will produce neurohumoral changes especially in hypothalamo-pituitary-adrenal axis (Figure 1) and early stress and maltreatment leads to the emergence of psychiatric disorders during development.⁴ Increase in these hormones will help the individual to cope up with the stressful condition.

The effect of stress on HPT axis varies depending upon the type, duration of stress. Most of the previous studies reported that stress causes hypothyroidism but a strong debate is existed, because some other studies reported an increase in thyroid hormones. For example noise stress has been shown to increase⁵ TSH levels and a brief period of immobilization resulted in increase in TSH and T₃ levels.⁶ Stress inhibits thyroid stimulating hormone through the action of glucocorticoids on the nervous system.⁷ Stress causes hypothyroid symptoms by disrupting HPA axis, reduces the conversion of T₄ to T₃, promote autoimmunity by weakening immune barriers, causes thyroid hormone resistance and causes hormonal imbalances.⁸

Stress will stimulate the HPA axis and increase the production of corticosteroids (Figure 1) and vestibular stimulation will relieves stress related changes in HPA axis.^{9,10} Evidence indicating that stressful conditions causes adaptation in thyroid functions, initial change observed in serum protein bound iodine levels comes similar to the initial level following intervention.¹¹ The impact of cold mild stress will reduce the T₃ and T₄ levels, these altered thyroid function in turn alter the immunity.¹² During stress Corticotrophin-releasing hormone suppress the thyroid function by inhibiting the secretion of thyroid releasing hormone and thyroid stimulating hormone.¹³ Prenatal stress in pregnant female rats, the fetuses exhibit altered somatotopic and endocrine activities due to alteration in HPA axis.¹⁴ Short time exposures to cold air do not cause any changes in serum levels of thyroid hormones or TSH. Long-term exposures to cold air speed up the consumption of thyroid hormones. It firstly manifests as low levels of free T3 and free T4.¹⁵ Recent studies shows that, mood disturbances are very common in humans working in Antarctica, their serum free T3 levels were found to be low¹⁶ and supplementation with T4 was found to improve cognitive performance.¹⁷ Hence changes in thyroid function in stress is inevitable and widely reported.



Interactions between thyroid function and vestibular stimulation

Vestibular apparatus is known as membranous labyrinth and is enclosed in bony labyrinth of temporal bone. Vestibular apparatus consists of otolith organs and three semi circular canals. Vestibular stimulation relieves stress, pain, promotes sleep, improves cognition, immunity, balance food intake and also treats endocrine disorders.¹⁸⁻²² Anxiety patients with poorly adaptation to vestibular lesion are parallel to quality and quantity of stress.²³ Recent study reported that, vestibular stimulation will significantly reduce the cold water swing stress induced thyroid changes in *Wistar albino* rats. It is due to inhibition of stress axes by vestibular stimulation.²⁴

The interaction between the endocrine system and the vestibular system is mainly unexplored.²³ Hence vestibular stimulation is considered as a supplementary treatment for hypothyroidism.²² Vestibular stimulation controls stress induced changes in thyroid function by two ways. Thyrotropin releasing hormone from the hypothalamus plays key role in the regulation of thyroid secretions. Evidence indicating that, there are some direct connections existing between hypothalamus and vestibular system. Vestibular system directly modulates thyroid hormone secretion through its connections with paraventricular nucleus and arcuate nucleus.²⁵ Medial vestibular nucleus receives direct connections from hypocretin (orexin) neurons of lateral hypothalamus.²⁶ Thyroid deficiency may cause vestibulopathy to central vestibular disorders affecting cerebellum.²⁷ Studies shows that caloric vestibular stimulation causes changes in neuronal activity both inhibition and excitation of paraventricular nucleus in guinea pig.²⁸ Caloric stimulation of endolymph in guinea pig traced

the direct connections between vestibular nucleus and supraoptic nucleus and paraventricular nucleus of hypothalamus.²⁹

Indirectly it modulates thyroid function through HPA axis. Cortisol's have an inhibitory effect on neurons in the PVN of hypothalamus through depression of the noradrenergic system in rats.³⁰ vestibular stimulation suppress the stress axis. hypothyroidism is observed in female rats with a decreased corticosterone response to stress.³¹ AGRP innervations are present in TRH neurones in the PVN.³² An inverse relationship is exist between AGRP and HPT axis and also the stress has an impact in AGRP levels.³³ During starvation exogenous supplement of leptin blunts the changes in thyroid axis in male mice.³⁴ Leptin stimulate TRH biosynthesis by 7 folds, in addition of alpha-melanocyte-stimulating hormone (3.5-fold increase in TRH), whereas neuropeptide Y suppress pro-TRH biosynthesis (3-fold) and melanocortin-4 receptor antagonist SHU9119 partially inhibited leptin-stimulated TRH release from the neuronal culture of fetal rat hypothalamus.³⁵ NPY plays major role in controlling HPT axis, when administering NPY in blood it will cause suppression of thyroid hormone and stable or low level in TSH.³⁶ We concluded that vestibular stimulation directly modulates stress induced thyroid changes and indirectly by suppressing stress axis.

CONCLUSION

We conclude that vestibular stimulation may be used as a supplementary therapy for thyroid disorders. We suggest detailed studies in this area to explore importance of vestibular stimulation in the management of thyroid disorders.

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CONFLICT OF INTEREST

The author declare no conflict of interest.

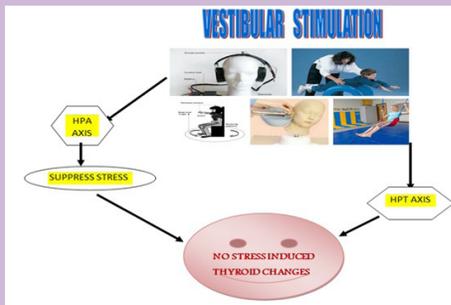
ABBREVIATION USED

HPA: Hypothalamic-Pituitary-Adrenal axis; **HPT axis:** Hypothalamic-Pituitary-Thyroid axis; **CRH:** Corticotrophin releasing hormone; **ACTH:** Adrenocorticotrophic hormone; **TRH:** Thyrotropin releasing hormone; **TSH:** Thyroid stimulating hormone; **PVN:** paraventricular nucleus; **NPY:** neuropeptide Y.

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PICTORIAL ABSTRACT



SUMMARY

- Stress is part and parcel of our life. But, beyond some point, stress becomes distress basically individual's response to fight/flight a situation. Stress when pathological, causes lot of physical and mental health problems.
- Stress modulates thyroid secretion through HPA (Hypothalamic-Pituitary-Adrenal axis) and HPT axis (Hypothalamic-Pituitary-thyroid axis).
- Vestibular stimulation prevents stress induced changes on thyroid secretion through direct and indirect pathways.

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