

Role of yoga in hormonal homeostasis

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Abstract

There is dearth of randomized controlled trials and studies and lack of information about the duration of therapy, side-effects, contraindications, compliance and long-term effects of yoga practice for most of the endocrine disorders. In this review, we have discussed the effect of yoga on plasma levels of hormones and neurotransmitters. The analysis and interpretation of this data can be useful to encourage research and therapeutic trials in many endocrine disorders. The mechanisms contributing to the therapeutic benefits of yoga include stress reduction, alteration of hypothalamopituitary adrenal axis, balancing the autonomic nervous system and immune modulation. This review includes the studies that describe the changes in the neurotransmitter and hormonal levels by yogic interventions to achieve improvements in the metabolic profile of yoga practitioner.

Key words: Endocrine glands, hormones, hypothalamopituitary adrenal axis, yoga

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INTRODUCTION

The therapeutic role of yoga by various techniques in the field of endocrinology focuses mainly on diabetes, and very little work has been done related to other endocrine disorders. This review elaborates the role of yoga in maintaining the hormonal balance and refers to both neuroimaging techniques and hormone analysis studies that explore the various mechanisms involved.

Most studies have used an integrated yoga course or practices of sahad, hatha and sudarshan kriya yoga with asanas, pranayama and meditation techniques, including dhyana, transcendental, omkar and amrita meditation. Levels of corticotrophin releasing hormone (CRH), melatonin, growth hormone, prolactin, luteinizing hormone, thyroid hormone, cortisol, aldosterone, testosterone, adrenaline and other neurotransmitters like endorphins, serotonin, 5-hydroxy indole acetic acid (5HIAA), vanillyl mandelic acid (VMA), dehydroepiandrosterone, gamma amino butyric

acid (GABA), and 8-hydroxy deoxyguanosine are affected in yoga practice. There is improvement in insulin secretion and sensitivity and this ultimately decreases blood glucose level in diabetics. The benefits of yoga is also related to other risk factors like high blood pressure, lipid levels, oxidative stress, coagulation profile and immune status and may also influence the metabolic profile. This review is different from other reviews as in addition to the role in diabetes, the changes in the levels of stress related and other hormones and neurotransmitters have also been mentioned in this article.

DIABETES AND STRESS

Diabetes is a lifestyle disease reported in about 171 million patients in the world, 17.7 million in US and 31.7 million in India in the year 2000. By 2030, India will be topping the list with an expected 79.4 million diabetics and the likelihood of 30.3 million in US and 366 million in the world.^[1] As the age of onset of diabetes is decreasing and prevalence is increasing, there is a need to change the dietary habits, increase physical activity and include those interventions which can bring about weight reduction.^[2] The pathogenesis of diabetes is influenced by stress which is known to affect the hypothalamopituitary adrenal axis (HPA).^[3] There is a link between HPA axis, autonomic nervous system (ANS), adrenomedullary system and immune responses. Stress causes sympathetic activation, parasympathetic withdrawal and increase in cortisol and noradrenaline levels, which in turn enhances proinflammatory cytokines

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like interleukin (IL-1, IL-6, IL-10) production and decreases interferon gamma. There is stimulation of the type 2 helper cell (TH2) mediated immune response and decrease in innate immunity.^[4,5] Chronic activation of the HPA axis is seen in diabetic patients with poor glycemic control and neuropathy.^[6,7] Furthermore, inflammatory processes are associated with progression of type 1 diabetes and inflammatory cytokines are linked to the development of insulin resistance in type 2 diabetes.^[8]

YOGA AND DIABETES

Most of the works related to yogic practice have been carried out in type 2 diabetic patients. The associated risk indices have been evaluated in about 25 studies with yogic intervention ranging from 8 days to 12 months.^[9] These include decreased blood glucose^[10] and glycosylated hemoglobin level^[11] and showed improvement in the glucose tolerance test (GTT).^[12] A decrease in fasting insulin level, rise in insulin receptors, increased percentage of receptor binding (even before glycemic control) suggests decreased insulin resistance and improved sensitivity.^[13-15] This has also been observed in individuals practicing yoga for more than a year where fasting insulin levels were measured using hyperinsulinaemic-euglycemic clamps.^[16] Stability in insulin requirement and a decrease in dosage of oral hypoglycemic drugs over time have been observed in diabetics practicing yoga.^[12,17] In a recent study, the symptoms in diabetics were scored on a 4 point severity scale. This average score decreased from 2.83 to 1.66 and the medication scores indicating number of drugs used decreased from an average of 2.83 to 1.6.^[18] Also yogic practices have reduced the risk factors such as cholesterol, lipid profile, oxidative stress,^[10] and blood pressure^[11] and have stabilized the coagulation profile,^[19] and autonomic function.^[9] There have been reports of weight loss, decrease in body mass index and waist-hip ratio, stress reduction, improvement in mood and self-efficacy and quality-of-life.^[20,21] Yoga has shown improvement in nerve conduction and cognitive functions in diabetics, a feature, which may prove to be beneficial in management of diabetic complications.^[22,23] Most of these studies have reported short-term improvement in diabetics, but it is not known whether all these changes are significant or sustainable.^[24] Nevertheless, yoga is a cost effective method without side effects and also holds much promise to improve the metabolic status of patients.^[25] Physicians should therefore advise their patients to adopt yogic lifestyle as a part of disease management.

YOGA AND OTHER ENDOCRINE DISORDERS

In fibromyalgia patients, yoga therapy was used to alleviate pain and weakness. It was associated with an

increased levels of cortisol.^[26] Also, yoga has shown promising results in polycystic ovarian syndrome patients by reducing the levels of antimullerian hormone, luteinizing hormone and testosterone,^[27] improving the bone density in osteoporosis patients and increasing the survival rate in cancer patients.^[28,29] Yoga is also known to improve adiponectin levels in obese postmenopausal women.^[30]

MECHANISM OF EFFECTS OF YOGA

A few studies have explored the mechanisms involved in the therapeutic benefit of yoga. Interactions between the central nervous system, limbic system, ANS, HPA axis and the immune system work together to maintain the hormonal homeostasis.

Yoga and hormones/neurotransmitters

Most studies evaluating the effect of yoga on other hormones do not mention any endocrine disorder. There is an alteration in hypothalamic and pituitary function following meditation.^[31] Studies have shown a decline in adrenaline and cortisol levels following Amrita meditation.^[32] Lower level of cortisol in long-term transcendental meditation practitioners,^[33,34] and an increase in cortisol in long-term yogic practitioners have been reported.^[35] Although serotonin is generally considered a hormone of rest and fulfillment,^[36] decrease in its level following meditation has been noted.^[37] In addition, practitioners of transcendental meditation had a decrease in VMA excretion with higher blood levels of dehydroepiandrosterone sulfate and serotonin metabolite, 5-HIAA and lower levels of aldosterone.^[34] However, decreased catecholamine levels^[38] and increased excretion of VMA, norepinephrine and epinephrine in urine have also been reported in advanced meditators.^[39] Decreased levels of 8-hydroxydeoxyguanosine, an indicator of psychological stress,^[40] and increased levels of β endorphin is seen in individuals practicing yoga.^[41] Meditation is also associated with an increase in melatonin levels.^[42,43] In a study evaluating the hormonal response to transcendental meditation, no changes in renin and aldosterone levels were observed, but these mediators were less responsive to acute stress.^[44] A decrease in both triiodothyronine and growth hormone during meditation has also been reported, although yogic practices specifically the Sarvangasana increases the protein bound iodine and rehabilitates the thyroid gland probably by increasing the microcirculation and function.^[31,45] An acute increase in GABA has been found following 60 min session of yoga as shown by magnetic resonance spectroscopy.^[46] Another finding that needs to be justified is the increase in prolactin found in the postmeditation period both in short-term and long-term yoga practitioners and after exercise following practice

of sudarshan kriya.^[47,48] All these cumulative data suggest that yoga influences the levels of stress related and other hormones and thus plays a vital role in maintaining the hormonal homeostasis [Figure 1].

The hormonal response depends upon the type of meditation and the duration of experience of the meditators. This could explain the differences in the hormone profile observed in some studies. In a study comparing the transcendental meditation practitioners with Tibetan one-point and compassion techniques, psycho-physiological effects were found to be different. The author stated that different techniques may produce different results.^[49] Also, functional magnetic resonance imaging studies have shown that brain activity in regions associated with attention vary over the time of meditation session and differ between short and long-term practitioner.^[50]

A few symptoms experienced during yoga and meditation can also be explained in the context of the neurotransmitter involved. Joy and euphoria is associated with increase in β endorphin, serotonin and dopamine levels. Arousal is due to increase in arginine-vasopressin, resulting from less GABAergic inhibition of supraoptic area of the hypothalamus. The ecstatic and blissful feeling following yoga practice could be due to lateral hypothalamic stimulation, and feeling of calmness may be due to melatonin. A reduction in GABA may cause decreased spatial orientation and increase in both N-acetylaspartylglutamate (analogous to Ketamine)

and 5-methoxydimethyl tryptamine (from pineal enzymes) have been linked to out of body experience during meditation.^[41]

Yoga and the central nervous system

An article by Woodyard suggests that yogic practices result in increased tranquility of the mind and attention and a decrease in irritability.^[51] Yoga decreases the perceived stress through the cerebrohypothalamic or corticolimbic pathway,^[52] by influencing the cortical areas that affect the neurotransmitter and hormonal release.^[41]

In an article on the neurobiology of spirituality, it is reported that there is activation of the prefrontal and inhibitory thalamic reticular nucleus and a decrease in the parietal lobe activity with deafferentation of posterior superior parietal lobule following meditation as seen by various neuroimaging techniques.^[53] A positron emission tomography study on yognidra showed that meditation is accompanied by increased perfusion of the sensory system, hippocampus, association areas, and a decreased perfusion of the executive system namely the pons, striatum and the cerebellum.^[54] This view is reinforced by another study following Iyengar yoga with asanas and Ujjayi breathing. Measurement of cerebral blood flow using single photon emission computed tomography showed activation of the right frontal lobe, prefrontal cortex and right sensory motor cortex.^[55] Meditation of kundalini yoga may increase the hippocampal and right amygdala activation, and increase in parasympathetic response through right ventromedial hypothalamic stimulation.

Yoga and the autonomic nervous system

The ANS influences both the HPA axis and the immune response. Yogic practices may condition the limbic system that regulates the homeostatic mechanisms through the ANS-endocrine modulation.^[56] Yogic dhyana (meditation) and dharana (concentration),^[57] and pranayama that involve concentrating on the breathing pattern, breathing through either or both nostrils, may regulate the functions of ANS.^[58,59] Increased parasympathetic response following VMH could result decrease in both heart rate and respiration that leads to decrease in the stimulation of locus coeruleus by paragigantocellular nucleus. This reduces noradrenaline release, which in turn suppresses activation of the paraventricular nucleus and thus decreases CRH and cortisol secretion.^[41] It is known that reverberatory neural connections exist between the CRH and noradrenergic neurons. Also neuropeptide Y, somatostatin, galanin are co-localized with CRH in noradrenergic neurons. The ANS also induces secretion of IL-6, which stimulates glucocorticoid secretion and thereby exerts systemic effects on immune organs.^[4]



Figure 1: Yoga regulates level of hormones and neurotransmitters that effect physiological functions. GH: Growth hormone, T3: Triiodothyronine, GABA: Gamma amino butyric acid, VMA: Vanillyl mandelic acid, HPA: Hypothalamopituitary adrenal axis

Yoga and metabolic profile

Most studies evaluating the benefits of yoga have used a combination of various asanas, but have not tried to suggest the most appropriate asana for a particular endocrine imbalance. In one study the asanas used for diabetes control were suryanamaskar, trikonasana, tadasana, sukhasana, padmasana, pashmitottanasana, ardhymatsyendrasana, pawanmuktasana, bhujangasana, vajrasana, dhanurasana, shavasana and bhastrika pranayama.^[60] Asanas increase muscular activity, strength and endurance, improve the flexibility and balance.^[61,62] These asanas also affect body weight, body adiposity and dyslipidemia, by increasing the number of insulin receptor on the muscles and decreasing the blood sugar levels.^[63] This could explain the decreased level of insulin compared to their baseline values in healthy individuals after practice of asanas. However, the response to oral glucose challenge showed a higher insulin value at 30 min of GTT after setubandasana and pawanmuktasana.^[64] Regular practice of yoga has been reported to improve the cardiovascular profile and oxygenation of all organs including endocrine glands. The massage of various organs and increased venous return from them as a result of compression and release could be beneficial in endocrine disorders,^[51,65] and especially good for diabetic patients in whom alternate abdominal contraction and relaxations may rejuvenate the pancreatic cells and increase β cell sensitivity.^[66] It is now believed that relaxation responses by techniques like yoga including meditation can also modulate gene expression.^[67] However, this mechanism needs to be further explored. If detailed studies are conducted in future, it could prove to be a paradigm shift in understanding the hormonal homeostasis and management of endocrine disorders.

Yoga and immune response

It is believed that stress triggers a neuroendocrine response that causes immune dysregulation and altered cytokine production, which could be one of the multifactorial cause of autoimmune diseases.^[68] Meditation is known to decrease

the release of IL-6 and its levels are found to be less in yoga experts compared to novice yoga practitioners.^[69] Thus, yoga may help in immunomodulation [Figure 2].^[70] Similarly in a study evaluating examination stress, there was an increase in cortisol and decrease in interferon gamma, but this effect was less in yogic practioners. Yoga prevents the proinflammatory response induced by stressors and also the cellular immunity.^[56] Similarly, transcendental meditation is found to decrease the acute stress inflammatory response and, sudarshan kriya and pranayama are known to improve the immune function.^[33,71] This may also occur at the genetic level by up-regulation of antiapoptotic genes, thus prolonging the lifespan of lymphocytes and improving the immune status, as was seen in individuals practicing sudarshan kriya for a period of 1 year.^[72] This beneficial effect of yoga may indirectly affect the pathogenesis of all immune related endocrine disorders. In a study, it was reported that insulin epitopes may be involved in triggering the autoimmune response in type 1 diabetes. The researchers suggested that interventions to decrease metabolic stress may reduce this antigenic response and recommended preventive strategies especially in individuals at risk, like 1st degree relatives of diabetics.^[73] Yoga could be one such intervention that prevents the occurrence and progression of metabolic deterioration and co-morbidity. Yoga is thus a scientific lifestyle with diverse effects to regulate the physiological functions.^[74]

CONCLUSION

This review has attempted to explore the beneficial effect of yoga on various hormone levels. It however does not suggest which yoga practice is specific for a particular endocrine disorder, because such scientific data are not available as yet. Also, this review does not provide an answer to the duration of practice required or whether the effects are sustained after cessation of yoga practice. Nevertheless, the present review provides ample evidence to suggest that yoga may reduce stress, improve metabolic profile, maintain the hormonal

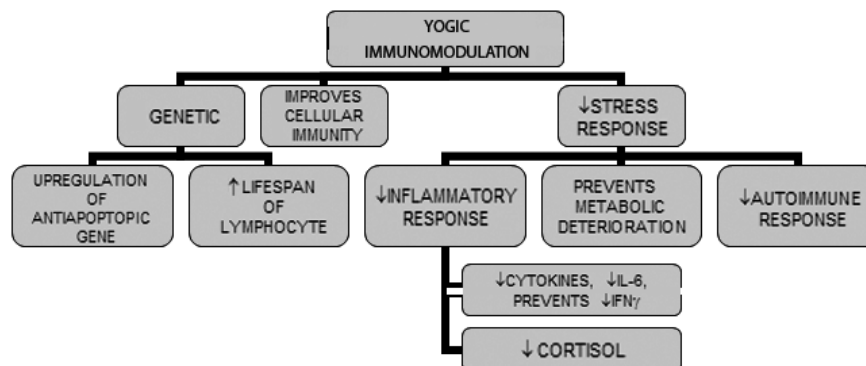


Figure 2: Yoga influences the immune response

balance by regulating the HPA axis and the ANS and also contributes to immunomodulation. Thus, all these effects ultimately bring about hormonal homeostasis. This review should encourage scientists to conduct further research that could alleviate the sufferings of patients with endocrine disorders. This review has also attempted to provide a scientific explanation to the rationale of lifestyle management, which in future may be included as a part of therapy for such patients.

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