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Review article

Yoga in Diabetes: Is it really worth Practicing?

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Abstract:

As per International Diabetes federation (IDF) data, the global burden of diabetes management has been US$ 673 billion in 2015, accounting for 12% of the global healthcare expenditure. In addition to the medications, lifestyle modification plays a major role in attaining glycemic control and hence reduce the risk of cardiovascular disease in these patients. Yoga, an ancient *Vedic* science, thought to have originated in India in 5000 BC, is one of the best lifestyle modifications and is being applied in the field of therapeutics. Studies show that Yoga practices not only improves glycemic control in Diabetic patients but also effective in managing dyslipidemia, Blood pressure control, and improves cardiac and pulmonary functions in these patients. Psycho-neuro-endocrine system, autonomic nervous system regulation and various immune mechanisms are involved in these beneficial effects. Considering the various complexities of current treatment plans for control of T2DM, Yoga can be considered as a cost effective and non-invasive adjuvant therapy for these patients.

Key Words: Yoga, Diabetes Mellitus

Introduction:

Yoga is an ancient technique of keeping physical , mental and spiritual wellbeing and away from stress. Stress can be classified as endogenous or exogenous. The Stress smothers body's immune response and neuro-hormonal activities which in this manner influences the psychological response, this eventually is identified with cardiovascular and metabolic ailments like diabetic diseases(1-3). Yoga is one of the best lifestyle modifications and an ancient *Vedic* science thought to have originated in India in 5000 BC which is being applied in the field of therapeutics.(3,4) An examination announced that impact of pressure influences insusceptible adjustment and safe homeostasis by upsetting neuro-endocrine and hypothalamus function(3). Any sort of stress can influence balance among sympathetic and parasympathetic frameworks by discharging expanded convergences of catecholamines and

cortisol. This reaction is regular 'fight or flight' that is experienced by hyper mobilization of vitality required to retaliate pressure. This constant condition of hyper vigilance that outcomes from visit terminating of HPA hub prompts dysregulate ordinary working of body and offer ascent to illnesses, for example, diabetes, sorrow, weight and cardiovascular sicknesses which are for the most part identified with pressure.

It is proposed that pressure prompts:

- (1) imbalance of the autonomic nervous system (ANS) with decreased parasympathetic nervous system (PNS) increased sympathetic nervous system (SNS) activity,
- (2) underactivity of the inhibitory neurotransmitter, gamma amino-butyric acid (GABA) and
- (3) increased allostatic load, allostasis is the adaptive mechanism of maintaining optimal homeostasis as stated by Mc Ewen (2007) and allostatic load is the cost to maintain this homeostasis which is reflected in the form of pathophysiological condition and disease progression. (4)

Effect on medical conditions

Two hypotheses have been proposed to clarify how yoga functions in diseases with overlapping pathophysiology based on the principle that yoga practice reduce allostatic load in stress response systems and to restore optimal homeostasis. (5)

- Vagal stimulation
- Parasympathetic stimulation and HPA axis modulation.

1. Consequences for baroreceptor affectability: -

   Baroreceptors are the mechanoreceptors which sense the change in blood vessel strain when in stretch ,otherwise called stretch receptors. They are transformed nerve endings that are connected to cytoskeleton which is available between nerve endings (Fig.3) The receptors are sensitive to rapid offsets in blood pressure. The baroreceptors are densely situated on the walls of the arch of aorta and the carotid sinus. They have an intrinsic potential to generate action potentials at a particular frequency at all times. This frequency is increased when the baroreceptors receive a stretch stimulus secondary to increase in blood pressure. The carotid sinuses increase their rate of impulse generation when the pressure in them builds up to values greater than 50 mm Hg. Below this threshold pressure, the carotid baroreceptors fail to initiate an action potential. On the other hand, the arch of aorta can record drops in blood pressure up to 30 mm Hg. The upper limit for blood pressure, after which the frequency of action potential stops increasing, is 175 mm Hg. The normal MAP is calculated to be 93 mm Hg. At this pressure, the baroreceptors are believed to be the most sensitive and even slight changes in pressure will result in rapid firing of action potentials.

   The baroreceptor reflex has three units:

   - Afferent nerve conveying driving forces from the receptors
   - Central handling unit
   - An efferent nerve that innervates the effector

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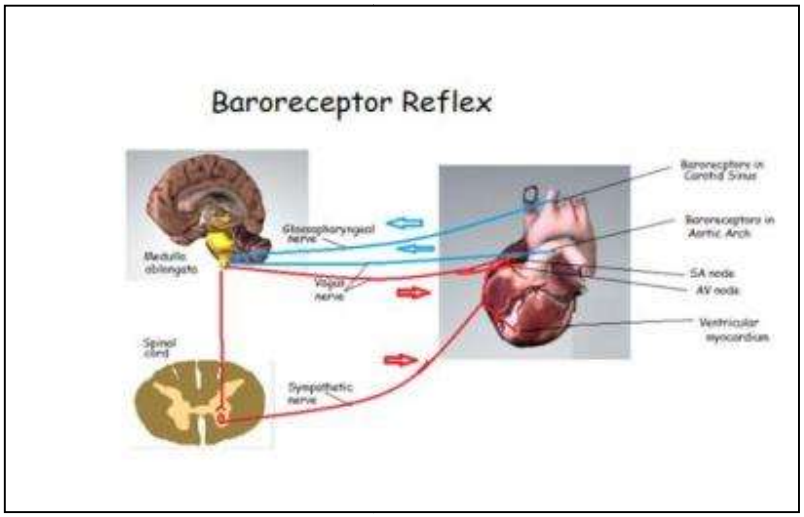

Fig.1 showing components of reflex arch

Yoga probably improves the baroreflex sensitivity, it additionally improves endothelial function and decreases cardiovascular disorders. (6-11). Brown and Gerber have reviewed the evidence that yoga-breathing interventions increase heart rate variability (HRV), improve sympatho-vagal balance, and promote stress resilience. (12-14) For example, Coherent Breathing and Resonant Breathing, using a fixed rate of three and a half to six breaths per minute (bpm), increase HRV and PNS activity (15-17). Ujjayi (Ocean Breath) is one form of resistance breathing that uses laryngeal contracture and partial closure of the glottis to impede the flow of air. Resistance breathing techniques increase intrathoracic pressure, baroreceptor stimulation, respiratory sinus arrhythmia (RSA), and HRV (18). The ancient 'Om' chant involves slow breathing, airway resistance (contracting the vocal cords to generate sound), which increase vagal tone and physiologic relaxation (19,20).

2. Parasympathetic and HPA axis

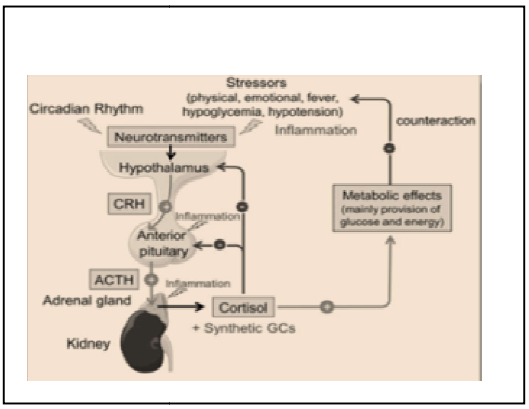

Fig.2 Showing Hypothalamo-pituitary adrenal axis

Other postulated mechanism of action of yoga is through parasympathetic activation and HPA axis(Fig.2) modulation. This response is mainly mediated through corticotrophin releasing hormone (CRH) from paraventricular nucleus(PVN) of hypothalamus , that binds to pituitary receptors and releases adrenocorticotrophic hormone(ACTH) which induces the adrenal glands to release mineralocorticoids and glucocorticoids (21). CRH receptors are also found in the hypothalamus, amygdala, hippocampus, basal nucleus of the striatum (BNST), central gray area, locus ceruleus (LC), parabrachial nucleus (PBN), dorsal vagal nucleus, prefrontal cortex and anterior cingulate gyrus (22,23). Chronic stress results in prolonged increases in glucocorticoid levels (4). High levels of circulating glucocorticoids provide negative feedback that reduces PVN synthesis of CRH but activates CRH release in the central nucleus of the amygdala (CEA) (21). The action of CRH in the amygdala constitutes an additional mechanism for mediating autonomic and behavioral responses to stress including the promotion of anxiety, fear-based behaviors, and defensive reactions (21-22). Stress is associated with neuronal pruning and volume reduction in the hippocampus, which results in prolongation of HPA axis response to stress (4-24). In contrast, stress leads to increased dendritic branching in the amygdala (25). In summary, lesions of the hippocampus increase HPA axis response, whereas lesions in the medial amygdala decrease HPA axis response. Accordingly, there is a reduction in hippocampal function, reflected in decreased declarative memory, and an amplification in amygdala activity evidenced by increased fear response to behavioral stress (26).yoga helps in downregulation of the HPA axis (4) hence it can be postulated that it plays role in hippocampus and amygdala by alleviating the stress and its amplifiers which in turn improves overall metabolic and psychological profiles, increasing insulin sensitivity and improving glucose tolerance and lipid metabolism

YOGA AND DIABETES

A report by the international Diabetes federation (IDF) reveals the global burden of diabetes management has been US$ 673 billion in 2015,12% of the global healthcare expenditure (27). Recommended therapies for diabetes involve lifestyle modification and use of medications. Lifestyle modification plays a major role in controlling blood sugar levels, physical activity is known to improve glycemic control and reduces the risk of cardiovascular disease in patients of diabetes. (28). It is recommended that adults should indulge into moderate to vigorous intensity activity for 150 min over at least 3 days a week. (29) Diabetes, its complications and other comorbidities limits the physical activity in elderly patients. (30,31) Yoga practice is an alternative to physical activity which may help to increase the compliance in these patients and can be used as an adjunctive therapy in the management of diabetes mellitus. Yoga practice is a complex intervention with various components, including cleansing processes (kriya), postures (asana), controlled breathing (pranayama), meditation, relaxation, chanting mantras, yogic diet, code of conduct, philosophy, and spirituality. Many yoga practices have been found to be beneficial in the management of type 2 diabetes; however, their judicious use is recommended after a careful assessment.

Yoga and Diabetes

Studies have shown that yoga improves blood glucose, dyslipidemia, oxidative stress, BP, body weight, coagulation profile, heart rate and pulmonary functions in patients of Diabetes (32). A meta-analysis done by Jayawardena et al, showed a significant reduction in FBG (15.16mg/dl), PPBG (28.66mg/dl), HbA1c (0.39%) and BMI (0.71 kg/m^2) in the intervention group (yoga) compared to control group (physical exercise) in pooled analysis. However, no

significant difference was seen in the lipid profile and other body composition measures (WC and WHR) and blood pressure (SBP and DBP). (33) Glycemic control is directly associated with increased cardiovascular morbidity and mortality in type 2 diabetes, with studies showing a 1.18 increase in relative risk of cardiovascular disease for every 1% increase in HbA1c. (34) . Yogic practices shift autonomic balance to parasympathetic by directly increasing the parasympathetic output (35) which leads to down regulation of metabolic parameters (35).

Different yogic techniques

- **Suddhi kriya** (Cleansing practices)-
    - Abdominal pressure exerted during exhalation improves the efficiency of β-cells of the pancreas Helps in the production of insulin and controlling glucose levels in the blood . The 'vacuum' effect of this action , massages the internal organs and boosts metabolism and facilitates proper functioning of the abdominal organs [36] Increases glucose uptake, minimizes insulin resistance, and promotes the function of insulin by reducing fasting and post-prandial blood sugar levels [37]

  Kawabata (frontal brain purification) (5 rounds, 120 strokes)- breathing technique with forceful exhalations and automatic inhalations.

  Agnisar kriya (stimulation on digestion) (5 rounds)- pulling the abdomen in (uddiyan bandha) and snapping it backwards and forwards while holding one's breath

  Vaman Dhauti (stomach cleansing)-

  Shankhaprakshlana (intestine cleansing)
- **Surya namaskar** (5-10minutes)- Stimulates insulin production through brain signalling [37] Significantly decreases hip circumference, exerting beneficial effects on glycaemic outcomes [38]
- **Yoga postures: Asanas**

  Rejuvenates of pancreatic cells through the alternating abdominal contractions and relaxations involved in yoga practice Improves blood supply to muscles. Enhances insulin receptor expression in the muscles, causing increased glucose uptake by muscles [39] has positive effects on glucose utilization and fat redistribution in type 2 diabetes [36] Massages and pressurizes the pancreas, stimulating insulin secretion Exerts stimulating and energizing effects Squeeze the intestines to prevent stagnation of colonic contents Improve blood circulation

• Yoga stances: Asanas

Restore beta cells of pancreas by rotating stomach compressions and relaxations associated with rehearsing yoga. Upgrades articulation of insulin receptors in muscles that increases glucose take-up by muscles[39]. It affects fat redistribution and glucose usage in type 2 diabetes patients [36]

- Standing stances - Recommended to hold last posture for 15 seconds by gradually expanding period for as long as 1 moment.

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Trikonasan

(triangle pose)

Tadasan

(palm tree pose)

Tiryak tadasan

(bent palm tree pose)

Veerasan (warrior pose)

Seated poses - Recommended to hold the final pose for 15 seconds, gradually increasing the duration up to 1 minute

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Ardhamatsyendrasan (seated spinal twist)

Mandukasan (frog pose)

Ushtrasan (camel pose)

Paschimottanasan (seated forward bend)

Yoga mudra (forward bend)

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Prone poses - Recommended to hold the final pose for 15 seconds, gradually increasing the duration up to 1 minute

Bhujangasan (cobra pose)

Dhanurasan (bow pose)

Naukasan (boat pose)

Makarasan (crocodile pose)

- **Supine poses** - Recommended to hold the final pose for 15 seconds, gradually increasing the duration up to 1 minute
  - P avanmuktasan (wind releasing pose)

  - Supta vajrasana (supine thunderbolt pose)

  - Setubandhasan (bridge pose)

Matsyasan (fish pose)

- **Inversions** - Hold the final pose for 15 seconds, gradually increasing the duration up to 1 minute

  - *Sarvangasan* (shoulder stand)

  - Halasan (plough pose)

PRANAYAMA: - Regulated breathing practices - Augment cerebral blood flow and oxygenation, improving neuronal activities in the brain centres, including those present in the limbic areas, hypothalamus, and medulla, and improve sympathovagal outflow [40]

- **Anulom vilom (alternate nostril breathing) -** 5–10 minutes- Improves components of health-related fitness, i.e., cardiorespiratory endurance, flexibility, and body fat percentage [41]

- **Chandra bhedan (left nostril breathing) -** 5 minutes - Parasympathetic stimulation
- **Surya bhedan (right nostril breathing)** - 5 minutes - Sympathetic stimulating effect; may be recommended in people with diabetes [42]
- **Bhastrika (bellows breath)** - 3–5 minutes- Regulation of pineal, pituitary, and adrenaline glands, important role in the regulation of metabolism [43]

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- **Bhramari (humming bee breath) -** 5 rounds - Soothing and calming effect on the mind, improves mental and physical health [44]

with humming sound

- **Sheetali/Sitkari (cooling breath) -** 3–5 minutes - Lowers blood pressure, cooling effect

BANDHA: - Lock

Re-directs the flow of blood and lymph to other body parts Negative pressure created in the abdominal cavity may improve pancreatic function

Uddiyan bandha (abdominal lock) -5 rounds

***MUDRAS*: -** Hand gestures (15–45 minutes)- Promote deep relaxation and eliminate stress Boost metabolic rates, promote weight loss, and reduce sugar levels

Linga mudra

surya mudra

prana mudra

apan mudra,

gyan mudra

***DHYAN*: -**Meditation (10 minutes)- Beneficial psychological effects, such as faster reactions to stimuli and being less prone to various forms of stress [45], anxiety reduction, and blood pressure control [46] Positive effects on sugar levels.

Meditation on manipur chakra (solar plexus)

"*Aum"* chanting for 5 minutes- Stabilizes the brain, removes negative thoughts, increases energy, improves mind and body relaxation within minutes of practice [47] Chanting in the supine posture produces an integrated relaxation response [48]

"Aum" reciting for 5 minutes-It settles cerebrum, improves mind, evacuates negative contemplations, builds vitality, and body unwinding close to rehearse [47]. Reciting in prostrate stance creates an incorporated unwinding reaction [48]

***YOGA NIDRA*: -**Yogic relaxation for 30 minutes- Improved symptom score, reduction of fasting blood glucose and postprandial blood glucose levels [49].

According to the previous studies vakrasan, ardhamatsyenrasan, mandukasan, yog mudras, bhujangasan and dhanuasan were most effective among all and help in glycemic control as were hypothesized that they cause maximaum stimulation of pancreas. It's been derived that physical exercises asanas have better control on diabetes than breathing exercises.

Precautions

In a case study, a case of spontaneous pneumo-thorax caused by *Kapālabhāti Prāṇāyāma* was reported. Hence, *Prāṇāyāma* especially fast *Prāṇāyāma* should be practiced under the supervision of qualified yoga practitioners

Fast-paced yoga practice and vigorous exercises in extreme temperature conditions, as in hot or Bikram yoga, are not recommended for individuals with diabetes, cardiovascular disease, or who are at risk of complications

Yoga practices are generally recommended on an empty stomach, but those taking treatments for diabetes may take light snacks to prevent hypoglycemia

Inverted poses such as sarvangasan and sheershasan cause blood to rush or pool into the head and upper body, which may lead to a risk of retinal detachment or bleeding; such poses should be avoided in patients with diabetes or practiced with utmost care, only after an ophthalmic evaluation [33].

Balancing poses should be practiced carefully to avoid traumatic injuries.

Complications of diabetes, such as autonomic neuropathy, may cause dizziness when sitting or standing abruptly because of a sudden drop in blood pressure.

Individuals with diabetes are advised to enter and come out of poses slowly, pausing for a breath or two if required while practicing the pose.

Conclusion:

Yoga when practiced properly under supervision is a powerful tool to glycemic control.

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