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RESEARCH ARTICLE

EFFECT OF YOGA ON BIO- MARKERS LINKED WITH DEVELOPMENT OF DIABETES COMPLICATIONS IN TYPE 2 DIABETES PATIENTS: A PRELIMINARY STUDY

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ABSTRACT

Diabetes mellitus represents a metabolic disorder of multiple etiologies characterized by high level of glucose (hyperglycaemia) with disturbances in carbohydrate, fat and protein metabolism resulting from defects in either insulin secretion, or insulin action or both. Fourteen type 2 diabetic patients, aged 43-69 years with duration of diabetes ranged 1year-10 years were randomly selected and intervened for three months of exclusive Yoga practices. Research design used was Quasi- experimental Single Group pre test and post test. The investigation show non- significant difference in mean HbA1c values, whereas plasma TNF- α, BMI, systolic, diastolic blood pressure and pulse rate were significantly reduced. Thus, integration of yoga practices in day to day lifestyle of T2DM patients can be beneficial in controlling and preventing the progression of the disease and its associated complications.

INTRODUCTION

Diabetes mellitus (DM) has become one of the most common chronic diseases in the world; especially type 2diabetes mellitus (T2DM), is threatening to become the most serious epidemic of the 21st century (Ramachandran and Snehalatha, 2009). In the developing countries of the world, the prevalence of T2DM is more in the age group of 45- 64yrs of age where as in developed countries it is above 65 yrs of age (Wild *et al.,* 2004). Asian Indians have a strong genetic predisposition to diabetes (Sridhar, 2002), indicating a strong familial aggregation in this population (Ramachandran and Snehalatha, 2009). The impact of stress both physical and mental or psychological is very strongly related to development and progression of T2DM, especially in those with a strong genetic predisposition (Barroso, 2005), hence it is also known as "psycho- somatic disease".

T2DM is a condition in which a person has high blood glucose (hyperglycaemic) than the normal blood glucose concentration. This is either because the body does not produce enough insulin (insulin deficiency) and/or cells (insulin dependent) do not respond to the insulin that is produced by pancreatic β cells (insulin resistance). Several factors responsible for these conditions such as, insulin resistance, aging associated with physical inactivity, obesity, chronic hyperglycaemic stress, chronic oxidative stress, non-enzymatic glycation (AGEP), which in turn activate/ up-regulate metabolically triggered inflammation (sometimes referred as meta-flammation/ para-inflammation) and results into increase concentration of pro-inflammatory cytokines especially TNF- α, IL- 6 and IL-1β in the blood circulation (Wellen and Hostamisligil, 2005), (Hostamisligil, 2006), (Crook, 2004), (Head, 2006), (Katsuki *et al.,* 1998), (Pickup, *et al.,* 2000), (Lin *et al.,* 2005), (Meleth *et al.,* 2005), (Cohen, 2003), (Ramasamy *et al.,* 2005), (Ortega, 2005), (Kiecolt-Glaser *et al,* 2010).

In the last decade, use of complementary and alternative medicine (*CAM*) has widespread in developing countries and Yoga is one of the ancient CAM therapies known to the world. Practitioners of Yoga have long believed in its ability to treat chronic metabolic and/or psycho- somatic disorders (Sahay, 2007), (Jain *et al.,* 1993), (Gore, 1987), (Clay *et al.,* 2005), (Aljasir, 2010), (Derouich, 2002), (Gordon *et al.,* 2008), (Chaya *et al.,* 2006), etc. However, as per the author's impression on the basis of literature review, the physiological and immuno- biochemical basis of this belief has never been deeply focused in context of yoga, metabolism and immunity in type 2 diabetes patients. Thus, this study was intended to identify the role of yoga practices on concentrations of plasma HbA1c, plasma TNF- α in combination with physiological parameters such as, body mass index and blood pressure, to reveal the intricacies of immuno- biochemical pathways. If proved positive, the frequency of drugs can be lowered and their side effects can be avoided. Thus this will help the type 2 diabetes patients to maintain their healthy state of mind and body.

MATERIALS AND METHOD

Subjects

Fourteen type 2 diabetic patients, aged 43-69 years with duration of diabetes ranged 1 year to 10 years were randomly selected for the three month's Yoga practices programme, after approval of experimental protocol by the Institutional

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Ethics Committee. All the patients were non- alcoholic, non-smokers, middle class, literate and receiving oral anti-diabetic medicines. None of the patients had cardiac, renal, hepatic, retinal and neural or any other complications. Further, the participants were not having any acute systemic infection. Written informed consent was taken from each of them. (Table1)

Study Design

Quasi- experimental Single Group pre test and post test study design.

Intervention Protocol

Three months of Yoga practices protocol was designed by the Yoga expert from Kaivalyadham, Lonavla. The protocol consists of first 15 days training of Yoga asana (*physical postures*), Pranayama (*regulated breathing*) and relaxation followed by thorough practice for next 75 days to complete three months training programme. All the subjects (*except 6, dropped out*) attended the complete programme, which was conducted for 45- 50 minutes per day and 5 times in a week. The sequence of the practices is as follows, (Table 2)

Outcome Measures

Immuno- Biochemistry

The subjects reported to the laboratory in the morning (08:00am) without any food, drink or exercise prior blood sample collection. Blood samples were collected from the median cubital vein. Plasma Glycated Haemoglobin (HbA1c) was measured by Latex enhanced immunoassay (Ozone) [#]. Tumor Necrosis Factor alpha (TNF- α) was measured by using standard Human TNF- α pre- coated ELISA kit (Gen Probe) [#].

Physiology

BMI was calculated as body weight (Kg) divided by height (m) squared. Before and after Yoga training, Blood Pressure (B.P), Pulse rate and Body Mass Index (BMI) were measured by using digital BP machine, standard weighing machine and stadiometer for height estimation respectively.

Statistical Analysis

All data were inspected statistically and manually for normality, all the variables were described as mean ± standard deviation to determine the change within group by "Paired t test" using Minitab 15 statistical software.

RESULTS

There were 14 T2DM patients registered for study but only 8 patients could participated in the three months schedule. Following tables shows the observed changes in the selected immuno- biochemical and physiological variables associated with the Yoga practices. (Table3, Table4, Fig1)

promotion measure is "Yoga" (DiNardo, 2009). Yoga (Sanskrit term, meaning *yoke* or *union*) is an ancient healing, restorative and transformational discipline that originated in India at least 4000 years ago.

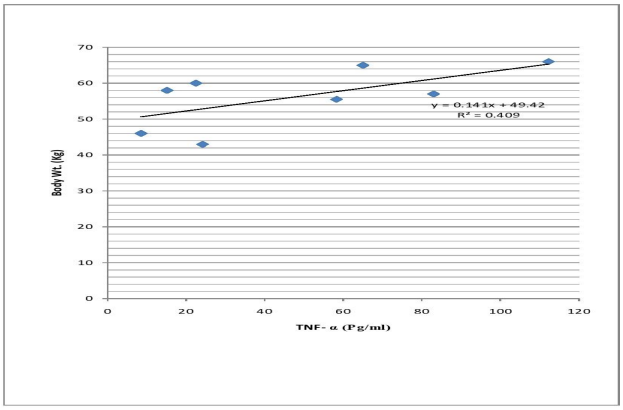

Figure 1 Post body weight and TNF-α Correlation

This study was specifically focused on the issue related to imbalance in metabolism and immune system i.e. meta-flammation or simply metabolically triggered chronic inflammation, in T2DM patients. The reason behind this selected pathway was increasing evidences on role of inflammatory cytokines in development and progression of T2DM (Pickup *et al,* 2000). Moreover, as the duration of disease (*diabetic progression*) increases, the pathophysiological conditions associated with it, such as chronic hyperglycemia (*glucose intolerance*), hyperinsulinemia (*insulin resistance*), dyslipidemia and chronic low grade inflammation due to imbalanced neuro-endocrine- immune axis/ HPA- immune axis, which may lead to consequences such as, diabetic neuropathy, diabetic nephropathy diabetic retinopathy, diabetic cardiomyopahy (*microvascular complications*) and coronary artery disease, peripheral vascular disease (*macrovascular complications*), (Head, 2006), diabetic retinopathy (Meleth *et al.,* 2005).

In this study, we have reported that, three months intense Yoga training, has improved glucose metabolism (*↓2.11 % mean HbA1c, p<0.36*) although the decrease was statistically non- significant. The possible mechanism for improvement could be the practice of selected asanas (*physical postures*) along with pranayama (*regulated breathing*) that might have improved the glucose uptake due to the stretching effect (physical mechanism, *proprioreceptors- stretch reflex mechanism*) of asanas, (Mougios, 1958), (Gore, 2008), which might have influenced glucose transport via muscle increasing GLUT4 translocation, the well studied mechanism involves activation of AMP-activated protein kinase (Mougios, 1958),

Table 1 Subjects characteristic *(n = 14)*

Mean age (Yrs.)	Sex (male: female)	Mean Height (cms.)	Mean Weight (Kgs.)
54.14 ± 8.63	3: 11	153 ± 7.54	62.1 ± 10.4

Data reported according to mean ± standard deviations

DISCUSSION

The Mind-body therapies, such as meditation, Yoga, qi-gong, and other relaxation techniques, have been studied in type 2diabetes patients. A popular mind- body therapy that may hold particular promise as a therapeutic as well as health

(Derouich, 2002), (Emily, 1999), this results into glucose uptake by skeletal muscle, cardiac muscle, and adipose tissues. Another probable mechanism responsible for improvement in glucose metabolism could be predicted as improved insulin signalling via down-regulating IKKβ/NF- κB pathway as a

Table 2 Yoga Modules

Sr. No.	Practices	Duration/day
1.	Meditation	2 mins.
2.	Shavasana (Corpse Pose)	2 mins.
3.	Ardhahalasana (Half plow pose)	30 secs.- 1 min.
4.	Ardhapavanmuktasana (Half gas relieving pose)	30 secs.- 1 min.
5.	Pavanmuktasana (Gas relieving pose)	30 secs.- 1 min.
6.	Naukasana (Boat pose)	30 secs.- 1 min.
7.	Makarkridasana (1- 4) (Crocodile pose)	30 secs.- 1 min.
8.	Niralambasana (Neck stretching pose)	30 secs.- 1 min.
9.	Bhujangasana (Cobra pose)	30 secs.- 1 min.
10.	Sarpasana (Snake pose)	30 secs.- 1 min.
11.	Ardha Shalabhasana (Half locust pose)	30 secs.- 1 min.
12.	Shalabhasana (Locust pose)	30 secs.- 1 min.
13.	Dhanurasana (Bow pose)	30 secs.- 1 min.
14.	Vakrasana (Twisted Pose)	30 secs.- 1 min.
15.	Parvatasana (Mountain Pose)	30 secs.- 1 min.
16.	Vajrasana (Pelvic Pose)	30 secs.- 1 min.
17.	Yogmudra (Symbol of Yoga)	30 secs.- 1 min.
18.	Bramhamudra (Neck rotation)	30 secs.- 1 min.
19.	Chakrasana (wheel pose)	30 secs.- 1 min.
20.	Tadasana (Palm-tree Pose)	30 secs.- 1 min.
21.	Trikonasana (Triangle Pose)	30 secs.- 1 min.
22.	Vrikshasana (Tree Pose)	30 secs.- 1 min.
23.	Anulom- vilome Pranayama (alternate nostril breathing)	1:2, (3) rounds
24.	Ujjayi Pranayama (Victorious breath)	(3) rounds
25.	Bhramari Pranayama (Humming bee breath)	(3) rounds
26.	Kapalbhati (Forced abdominal breathing)	10-30 strokes/round X (3
27.	Shavasana (Corpse Pose)	5-7 mins.

Table 3 Immuno- Biochemical Variables

Sr. No.	Variables	Tests	Mean ± S.D	Mean % change	't' Value	p- Value
1.	HbA1c (%)	Pre- test Post- test	7.13± 1.08 6.98± 0.46	2.11 % ↓	0.36	0.36
2.	TNF-α (pg/ml)	Pre- test Post- test	117.09± 104.63 48.60± 37.04	58.5 % ↓	1.90	0.05 *

Data reported according to mean ± standard deviations for normally distributed variables* P□0.05 (at 95% CI)

Table 4 Physiological Variables

Sr. No.	Variables	Tests	Mean ± S.D	Mean % change	't' Value	p- Value
1.	BMI (Kg/m^2)	Pre- test	25.75 ± 2.90	3.15 % ↓	2.44	0.02 ***
		Post- test	24.94 ± 2.88			
	Systolic B.P. (mmHg)	Pre- test	131.87 ± 17.35	9.1 % ↓	2.84	0.01 **
		Post- test	119.87 ± 13.01			
2.	Diastolic B.P. (mmHg)	Pre- test	83.87 ± 11.71	5.51 % ↓	1.79	0.05*
		Post- test	79.25 ± 8.190			
	P. R.(beats/ min)	Pre- test	79.25 ± 7.7	6.16 % ↓	1.78	0.05*
		Post- test	74.37 ± 6.09			

Data reported according to mean ± standard deviations for normally distributed variables * P□0.05 (at 95% CI), ** P□ 0.01 (at 99% CI), *** 0.01 < P < 0.05.

result of significant reduction in TNF- α gene expression as observed here (p <0.05).

The decrease in mean plasma TNF- α concentration (↓58.5 %, p <0.05) and decreased mean BMI (↓3.15 %, p<0.02) was significantly observed. The overweight induced inflammatory response could be managed by reducing the body weight and adiposity. The Pearson product moment correlation revealed the positive relation between reduction in body weight and metabolically triggered inflammatory response i.e. plasma TNF- α concentration (Fig1).

Significant decrease in mean systolic blood pressure (p <0.01), mean diastolic blood pressure (p <0.05) and mean pulse rate (p <0.05) was noted after three months intensive yoga practices. The reason could be the way in which asanas are performed i.e. smooth, slow and coordinated movements, with special attention to the respiration while performing and releasing asanas. This coordinated exercise not only improves the blood circulation around joints, surrounding muscles and tendons but also improves the muscle tone and greater elasticity of ligaments. The blood pressure, heart rate if increased, comes to the normal or remains within normal range without putting extra burden on cardio- respiratory system. In yoga, stabilization of mind and body is observed due to balanced function of sympathetic and parasympathetic nervous system rather enhanced parasympathetic tone. Yoga asana, pranayama and relaxation techniques aim at restoring the internal organs including endocrine glands into their normality through control or balance on HPA- immune axis and eventually may lead to improved and controlled functioning of all the vital organs, glands and Physiol-immuno-biochemical profile inT2DM patients, as observed here.

CONCLUSION

The findings of the study evaluates the efficacy of Yoga practices on fasting HbA1c, plasma TNF- α, body mass index, blood pressure and pulse rate in patients with T2DM. These findings show therapeutic and preventive role of selected yoga practices in reducing the metabolically triggered inflammatory response through balancing of HPA-immune axis, and improving the biochemical and physiological domains in T2DM patients. Thus integration of such yoga practices in day to day lifestyle of T2DM patients may be beneficial in preventing the progression of the disease and its associated complications.

Limitations of the study

The study was limited to the small sample size without control group. To observe the statistical effectiveness of the study, this preliminary study can be replicated on large randomized - controlled sample groups.

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