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Original Research Article

Effect of Yoga Asana on Glycemic Variability Monitored by Biosensors in Type 2 Diabetes Mellitus

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Abstract

Introduction: The 8th edition of International Diabetic Atlas states that South Asian region ranks second among all the IDF regions. As per census in 2015, 69.1 million adults are diabetic in India. One in eleven is a diabetic patient. Even worse finding is that 1 among 2 diabetic is undiagnosed. Exercise and lifestyle modification haven proven to be of great use in management of Diabetes Mellitus. However, autonomic failure can occur with association of hypoglycemia in secretagogue dependent type 2 diabetes mellitus populations when exercising. It is well understood that severe hypoglycemia can results in seizure, coma, and fatality. Evidence suggest that acute mild hypoglycemia may adversely affects cardiovascular parameters as well as endothelial function. Fear of hypoglycemia is prevalent among individuals with diabetes reliant upon exogenous insulin or insulin secretagogues. This fear is a big threat in achieving glycemic treat. Keeping this in mind the study is proposed to understand the glycemic variability when practicing the 6 asana in yoga (kapal bhati pranayama, supta matsyendrasana, dhanurasana, paschimottanasana, ardhya matsyendrasana, shavasana) of importance in stimulating the pancreas among the type 2 diabetes mellitus patients. **Objectives:** To understand the dynamics of insulin secretion in response to kapal bhati pranayama, supta matsyendrasana, dhanurasana, paschimottanasana, ardhya matsyendrasana, shavasana among type 2 diabetic mellitus patients. **Methodology:** After ethical approval from the institutional ethical committee, we propose to recruit 20 type 2 diabetic volunteers. After obtaining informed consent they would be fitted with biosensors marketed by Abbott laboratories over a period of 1 week. At the end of the week, we would monitor the glycemic variability. Parallel 20 healthy volunteers will also be fitted with biosensors and perform the same set of asanas. **Implications:** A comparison of glucose variability among diabetic subjects and healthy volunteers will help us to understand the body

insulin secretions in response to performance of asanas. On learning the intricacies in glucose levels, the diabetic subjects could very well encourage to perform the asanas. This study will help to overcome fear of exercise induced hypoglycemia and achieve favorable glycerin status.

Keywords: Diabetes Mellitus, Hypoglycemia, Insulin, Yoga, Pancrease Stimulation, Biosensors.

Introduction

In the present world, non-communicable diseases are becoming more common than the communicable diseases. NON-COMMUNICABLE DISEASES include Diabetes Mellitus, Hypertension, Psychological diseases etc. Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from decreased insulin secretion, insulin action, or both. Symptoms of hyperglycemia include polyuria, polydipsia, weight loss, and sometimes with polyphagia, also blurred vision. Growth impairment and susceptibility to certain infections may also accompany with chronic hyperglycemia. Acute, life-threatening complications of uncontrolled diabetes are hyperglycemia with ketoacidosis or the non-ketotic hyperosmolar syndrome.

According to INTERNATIONAL DIABETIC FEDERATION, diabetic atlas 8th edition, 82 million adults live with diabetes in the southeast region - the second highest of all IDF regions. India is home to the second largest number of adults living with diabetes worldwide, after China. People with diabetes in India, Bangladesh, and Sri Lanka make up 98.9% of the region's total adult diabetes population. India is home to the second largest number of children and adolescents aged 0-19 years with type 1 diabetes in the world (128,500), after the USA, and accounts for the majority of children and adolescents with diabetes in the SEA region. In 2017, 1.1 million people died due to diabetes, the second highest of all IDF regions. It was estimated that by 2040, this will raise to 150 million. For every 11 persons 1 person is diabetic and 1 child in every 6 births is affected by hyperglycemia in pregnancy. 2/3rd of people with diabetes was living in urban area and belongs to working age group. 1 in every 2 persons are undiagnosed.

Unhealthy eating habits are the major cause of diabetes in our cities and towns. The junk food that are fat and calorie rich are easily available. As a majority of the working population in country depend on these unhealthy fast-foods, leading to more prevalence of diabetes in urban population. The successful management of diabetes revolves around having a well-designed nutritional plan, exercise, use of oral hypoglycemic drugs or insulin. Regular monitoring of blood glucose levels by patient and consulting physician, and supportive education is important part of management.

In our country there are pre-diabetics along with diabetics. But the population of pre-diabetic is more than the diabetic. The pre-diabetic population were not diagnosed properly. They can be diagnosed with the help INDIAN DIABETIC RISK SCORE. According to IDRS, the categorizes in which the chances of getting diabetes in pre-diabetic patients are:

1) Age
2) Waist size/ circumference
3) Physical activity
4) Family history of diabetes

- Age being the primary factor of having diabetes while unhealthy

lifestyle is secondary and most important feature of having diabetes other than family history of DM

Table 1: The score given for categorizing into different groups are given in table 1

Parameters	Scores
Age (years)	
<35 (reference)	0
35-49	20
≥50	30
Abdominal obesity	
Waist <80 cm (female), <90 cm (male) (reference)	0
Waist ≥80-89 cm (female), ≥90-99 cm (male)	10
Waist ≥90 cm (female), ≥100 cm (male)	20
Physical activity	
Exercise (regular) and strenuous work (reference)	0
Exercise (regular) or strenuous work	20
No exercise and sedentary work	30
Family history	
No family history (reference)	0
Either parent	10
Both parents	20
Total score	
Minimum score	0
Maximum score	100

In developing countries, low-cost strategies for risk individuals of all classes, inexpensive lifestyle interventions like yoga are the best options. Yogic exercise is a moderate and static type of muscular exercise. This can be performed even by patients having limited joint mobility physical unfitness associated with overweight and sedentary lifestyle other than unwilling participation in hard and difficult type physical activities like gym-based training and vigorous strength exercises[1]. Yoga is the oldest and the most effective method for providing peace and maintenance of peaceful mind. It is known that yoga induces certain physiological as well as biochemical changes in volunteers[2]. A recent review suggested that yoga reduces the stress, improve metabolic profile, regulate autonomic nervous system and also alter hypothalamo- pituitory adrenal axis which act as neural mediators of hyperglycemia. There are few other reports which suggest that the influence of yoga on blood glucose level[3].

In yoga, abdominal stretching causes regeneration of cells of pancreas which results, increasing the utilization and metabolism of glucose in peripheral tissues, liver, and adipose tissues through enzymatic process. Improved blood supply to the muscles and muscular relaxation along with its development enhances insulin receptor expression causing increased glucose uptake and thus reducing blood sugar. The improvement in the lipid levels after yoga could be due to increased hepatic lipase and lipoprotein lipase at cellular level, which affects the metabolism of lipoprotein and thus increase uptake of triglycerides by adipose tissues. Yoga postures can lead to improvement in the sensitivity of the β-Cells of Islets of langerhans in pancreas to glucose signal and also the improvement in insulin secretion. Pranayama is one of the yogic postures which helps in the modification of various inflammatory and dilatory lung

reflexes and also protective against free radical damage and interact with central neural element to bring new homeostasis in the body[4].

The current study is taken up in order to look into these advantages of yoga on Glycemic variability in the Type 2 DM patients by 24-hour monitoring of glycemic variability with help of biosensors.

Aim:

Effect of yoga practices in the management of the Type 2 DM (T2DM) by monitoring glycemic variability with the help of biosensors.

Objectives:

1. To study the demographic profile of the participants in study and control group.
2. To know the 24-hour glucose fluctuations variability in study and control groups.
3. To know the effect of yoga practices in the management of type 2 DM by monitoring glycemic variability with help of biosensors.
4. To know the 24-hour glucose fluctuations variability in study and control groups.
5. To know the effect of yoga practices in the management of type 2 DM by monitoring glycemic variability with help of biosensors.

Materials and Methods:

It is a prospective clinical trial conducted on type 2 DM patients attending the outpatient department of General Medicine, in Sree Balaji Medical College & Hospital over a period of 1 month. Study started after getting permission from Institutional ethical committee. The study subjects were consisted of 30 diabetic patients attending diabetic clinic and 20 non-diabetic volunteers constituted control group. Diabetic patients were selected by simple random technique from the list of cases attended at outpatient unit of department of General medicine. Volunteers were recruited by their willingness to participants after they screened for eligibility to study. Questionnaire was distributed to eliminate confounding factors like drug history, surgical history, major illness, socioeconomic status, food habits, allergies etc.

Inclusion criteria:

- Age ranges from 25 to 55 years were included
- Patients with diabetes more than one year duration
- Age and gender wise matched healthy volunteers included as controls.
- Patients who are on diabetic diet and oral hypoglycemic agents (OHA) were included.

Exclusive criteria:

- Patients with severe complications.
- Patients with any other co morbid medical conditions.
- Patients with uncontrolled diabetes and necessitates the use of injectable insulin were excluded.
- Those who fulfilled the inclusion and exclusion criteria were selected after taking written informed consent.
- All the participants were trained by yoga experts and subjected to regular practice under supervision for one month.

The yoga was practiced daily in overnight fasting state at 6 AM and also at 7 PM according to standard principles and techniques regarding breathing, clothing, position, posture and movements as per given in table 2

First 2 weeks i.e., week 1 & 2, importance of Yoga and its uses, procedure to perform and principles of it were taught.

Later 2 weeks, (week 3 & 4) regular practice of yoga was done in morning (6:00–7:00 A.M) and also in the evening (7:00-8:00 P.M).

Table 2: Schedule of practices done along with the duration

S. No	YOGA PRACTICE	DURATION
1	Prayer	3 mins
2	Omkar recitation	3 mins
3	Pranayama	5 mins
4	Various asana (vajrasana, halasana, padangusthansana, dhanurasana, Bhujangasana, Paschimottanasana, Shalabhasana, Chakrasana ans Sarvangasana.	30 mins
5	Shavasana	5 mins

In both the groups, 24 hours glycemic variability was estimated with help of Abbott Biosensors. 24 hrs has been divided into 3 divisions as before, during and after yoga practice which is showed in table 3.

Table 3: Time distribution

S. NO	Category	Time division
1	Before yoga practice	5 hours before practice (1:00-6:00 AM & 2:00-7:00 PM)
2	During yoga practice	2 hrs (6:00-7:00 AM & 7:00-8:00PM)
3	After yoga practice	5hours after practice (8:00AM-1:00PM & 8.00 PM– 1.00 AM)

The data was entered into excel and analyzed using Statistical Package for the Social Sciences version 21 (spss 21), which were presented as percentages, mean, standard deviation (SD) and suitable graphs. Paired Student t-test was used to estimate difference in means calculated before and after yoga training in a same group. A p-value of <0.05 was considered as statistically significant.

Steps of undertaking the study:

1. Grouping of the volunteers into diabetic and non-diabetic groups.
2. Proper history taking of diabetic individuals.
3. Regular practice of yoga in both the groups for a period of 2 hours in a day for 1 month
4. Having healthy diet along with yoga practice in both groups.
5. Using of biosensor glycemic variability pattern as a direct consequence of the effect of the yogic posture can be evidenced.

Results:

All the members in the study group and also in the control group participated with full interest. Majority of the recruited diabetic patients were in the age group of 46-55 years (40%), control group were in the age group of 25-35 years (55%). In both groups males were more compared to females. The participant's in both the groups were comparable with respective to age, gender, height and weight. (TABLE- 4)

Table 4: Age, mean height and weight of participants

Categories		T2DM	Control	p-value
1.Age groups	25 – 35 years	8 (26.7%)	11 (55%)	0.116; NS
	36– 45 years	10 (33.3%)	5 (25%)	
	46– 55 years	12 (40%)	4 (20%)	
2. Gender	Male	19 (63.33%)	13 (65%)	0.904; NS
	Female	11 (36.67%)	7 (35%)	
3.Mean weight (Kgs)		75.19±6.37	71.68±7.33	0.08; NS
4. Mean height (Cms)		165.18±9.78	166.70±8.76	0.578; NS
5. BMI (Kg/m_2)		27.62±5.44	26.01±5.21	0.302; NS

Table 5: Relation of Mean glycemic levels with yoga in two groups for 15 days (3,4 weeks)

S.No	Time	Glycemic variability Mean ± SD	
		T2DM	Control
01	Before yoga practice period	168.21±6.22	115.57±5.22
02	During yoga practice period	151.36±7.13	102.57±5.46
03	After yoga practice period	134.22±5.61	93.05±4.39

Table 6: Intra-group comparison of glycemic levels with yoga for 2 weeks (3,4 weeks)

S. No	Comparison	T2DM		Control	
		t-value	p-value	t-value	p-value
1	Before Yoga and During Yoga	9.754	<0.001	7.696	<0.001
2	Before Yoga and After Yoga	22.226	<0.001	14.766	<0.001
3	During Yoga and After Yoga	10.348	<0.001	6.077	<0.001

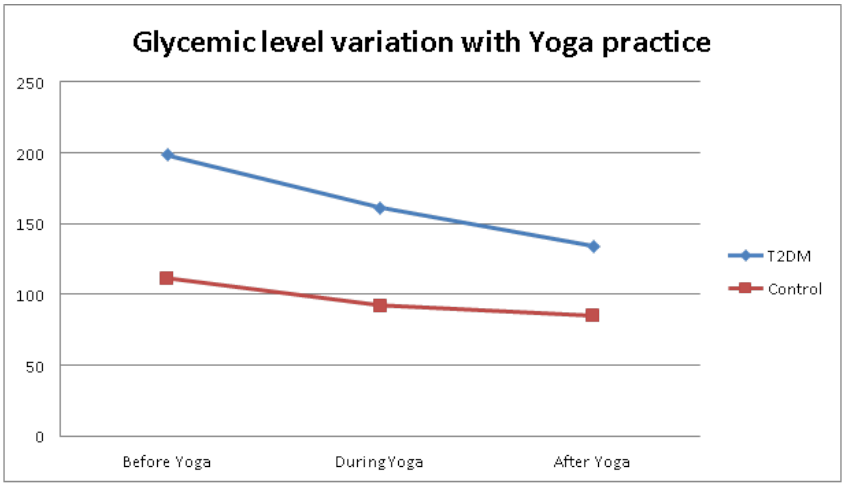

Figure 1: Mean glycemic level variation with Yoga practice for 15 days (3,4 weeks)

The reduction in mean glycemic values [Table-7 & fig 2] after the end of 1 month was highly significant (p <0.001) in both the groups when compared with the mean values before yoga practice.

Table 7: comparison of mean glycemic values of groups before and after the study period.

Groups	Before study	After study	p-value
T2DM	165.2±8.79	118.7±7.67	<0.001; S
Control	132.4±7.68	89.5±7.52	<0.001; S

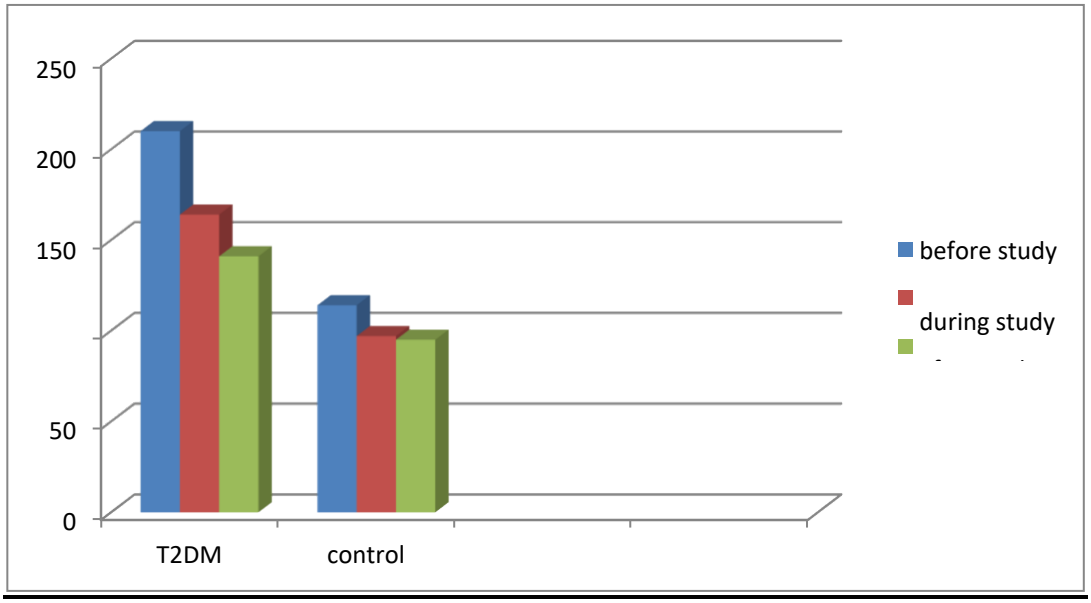

Figure 2: Mean glycemic values of both groups before and after study period.

Discussion:

The present study was aimed at studying the effect of yoga asana in patients with type-2 DM for 1 month. For this purpose, 30 diabetic patients and 20 volunteers were recruited. Both the groups were recruited in such a way that they were similar in basic characteristics such as age, gender, weight and height. So that effect of these factors on blood glucose could be minimized.

In the present study yoga was practiced by participants in two groups daily in overnight fasting state at 6 AM and also at 7 PM in the evening and 24 hours glycemic variability was estimated with help of Abbott Biosensors. The readings collected through sensors in 24 hours had divided into 3 divisions as before, during and after yoga practice.

The findings reported in the study were yoga helped to both diabetic and non-diabetic participants in controlling blood glucose levels. Both got significant reduction in blood glucose levels after yoga compared to before and during yoga. ($p<0.001$).

In the present study blood glucose levels after the study period were very much reduced in both groups compared to baseline values tested before the start of study. ($p<0.001$).

This shows yoga would help in controlling blood glucose levels not only in diabetic patients, but also in non-diabetic patients.

The possible mechanisms might be:

1. Direct regeneration of beta cells of pancreas due to abdominal stretching during yogic exercise, which may increase utilization and metabolism of glucose in peripheral tissues, liver and adipose tissues through enzymatic process[5].
2. More active practices followed by relaxing ones lead to deeper relaxation than relaxing practices alone, and possibility of neuroplasticity bringing about changes in the hypothalamic pituitarypancreatic axis[6].
3. Muscular relaxation, development and improved blood supply to muscles might enhance insulin receptor expression on muscles causing increased glucose uptake by muscles and thus reducing blood glucose[7].

Amita S, Gordon LA also suggested the similar way of positive effects of yoga on blood glucose levels in diabetic patients that are consistent with the results of present study. The reason of this consistency might be the mechanism that muscle contraction and relaxation in yogic postures stimulate the pancreas gland.[8] Similarly in a study by Sahay BK et al[9] also reported significant reduction in fasting and post prandial blood glucose within 3 months of yoga exercises in type-2 DM. They reported an improvement in insulin sensitivity and decrease in insulin resistance in subjects practicing yoga. Innes KE, Selfe TK et al[10] also reported that yogic practices may benefit the Type 2DM patients in achieving glycemic control. They also reported yoga also controls lipid levels, oxidative stress and blood pressure, which were not included in the present study.

In a study done by Subhash Manikappa et al.[11] also reported that reduction in mean values of FBS and PPBS at the end of six months was highly significant ($p < 0.001$) in both the groups when compared with the mean values before and during (three months) yoga practice. But in control group mean values of FBS and PPBS, before and during (three months) yoga practice was not significant. But in this study even in control group shows significant reduction in glucose levels between before and during yoga practice. The difference between these two studies may be due to participants in this study get adequate training of yoga practices for a period of 15 days before start applying the yoga practices.

In a study done by Savita singh et al[12] also reported a significant improvement in blood glucose (fasting and post-prandial), lipid profile and serum insulin compared to baseline values, thus suggesting a beneficial effect of yoga regimen on these parameters in diabetic patients. Asha Sharma et al,[14] in their study similarly reported that there was statistically significant decreased in mean values of FBG, PPG and HbA1C in the study group. There were no significant changes seen in control group as they didn't practiced yoga. But in the present study both the groups practiced yoga, so both groups experienced significant reduction in glucose levels. Sang dol Kim et al[16] reported that the exercise group measurements were significantly decreased in both life stress and postprandial blood glucose levels compared with the control group. These findings indicate that yogic exercises would reduce life stress and lower postprandial blood glucose levels in nursing students. The difference may be reference study participants doesn't follow strict diet plan unlike of present study. That might affect the result in reference study.

Summary:

The present study aimed at knowing the influence of yoga on the glycemic control of the type 2 DM patients. The summary of the findings observed in the study were

1. Glucose levels in the T2DM patients were reduced after the yoga practice compared to before yoga and during yoga practice.
2. The reduction of glucose is also observed in non-diabetes control groups.
3. The reduction in glucose levels were more as day advances in both groups.
4. The difference in glucose levels before start of study and after the study was significant, showed better control of the glucose levels in both the groups.

Limitations:

1. Lack of adequate sample to generalize the results because less people showed willingness to participate the study.
2. Inadequate study period to justify the findings.

Conclusion:

Finally, it is concluded that diabetes can be better controlled if yoga practiced simultaneously along with the conventional medicines. Similarly, non-diabetics also get benefitted by yoga in maintaining stable glucose levels. However, further extensive

and long-term studies need to be done to prove this and to understand the basic mechanisms involved.

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