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Effect of yoga therapy on glycemic parameters in type 2 diabetes subjects

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Abstract
Background: Diabetes mellitus (DM) a major health problem and effect of yoga on the endocrine system, nervous system and physical health are well documented. Anti glycemic activity of yoga is a potential area of study.
Aims & Objectives: To study the effectiveness of yoga intervention on glycemic status and anthropometry parameters in patients of type 2 Diabetes mellitus (T2DM).
Methodology: A hospital based prospective randomized trial was conducted on 104 patients of confirmed cases of T2DM. Subjects were randomized in two groups viz. Group 1 and Group 2 without and with intervention of yoga respectively (n=52). Anthropometric parameters were noted and serum glucose (Fasting & Post Prandial) and HbA1c were estimated.
Results: A significant improvement in Body Mass Index, Waist Circumference and systolic and Diastolic blood pressure were observed in diabetics of yoga group as compared to the non-yoga group. Significant decrease in plasma glucose and HbA1c levels was observed in diabetics of yoga group as compared to diabetics of non-yoga group. In conclusion, lifestyle intervention such as yoga improves glycemic control and can prove beneficial in prevention of complications of T2DM.

Keywords: diabetes mellitus, body mass index, glycosylated haemoglobin

Introduction

Diabetes mellitus (DM) a major health problem globally and is one of the top five leading cause of death in most developed countries. According to the International Disease Federation (IDF), India has more diabetics than any other nation of the world [1].

Keeping in view the alarming increase in the incidence and prevalence of diabetics in India, WHO has declared India as the- Diabetic Capital of the World [2].

Type 2 DM (T2DM) (non-insulin dependent DM) is the most prevalent form of DM categorized by hyperglycemia, resistance to insulin, and relative deficiency to insulin [3]. People with diabetes are at high risk of micro vascular complications including diabetic retinopathy, diabetic nephropathy, and diabetic neuropathy. With increasing rates of childhood and adult obesity, diabetes is expected to become even more prevalent in coming decades, and it remains a significant risk factor for the development of cardiovascular disease [4].

Recorded history of the yoga tradition starts with the Yoga Sutra, which is the definitive text on the philosophy of classical yoga. The mainstay of yoga practice involves the adoption and maintenance of specific body postures and the associated controlled breathing techniques. The ancient Indian classic on the practice of yoga, Gheranda–Samhita, notes that there are 840,000 asanas, though only one ten thousandth of them, or 84, are used in contemporary common practice. The yogic breathing technique of pranayama involves a slow deep breath inspired with the predominant use of the abdominal musculature and the diaphragm [5].

To implement of inexpensive lifestyle interventions in treatment & management of T2 DM yoga is one of the best option [6]. Lifestyle change is cornerstone of management of T2DM. Yoga is considered as one of the clinical viable treatment worldwide and is an emerging trend in healthcare field. Yoga, which is of Indian origin, is practiced worldwide for its health benefits, including physical fitness, relaxation and awareness of self. In Yoga, physical postures and breathing exercises improve muscle strength, flexibility, blood circulation and oxygen uptake as well as hormonal functions [7]. Sedentary habits and unhealthy dietary pattern are the major risk factors for the development of various lifestyle disorders, including diabetes. Lack of physical activity was found to increase the risk of diabetes by 3 times and the risk of coronary artery disease by 2.4 times [8]. By various yogic practices over a period of time significant physical, physiological, psychological and endocrinal changes have been reported [9, 10].

Oral hypoglycemic drugs have been used for the treatment of Diabetes. The drug categories include sulfonylureas, biguanides, alpha-glycosidase inhibitors, thiazolidinediones, and meglitinides. These drugs have various side effects e.g. sulfonylureas cause weight gain due to hyperinsulinemia [11, 12]. biguanides cause weakness, fatigue, lactic acidosis; alpha glycosidase inhibitor may cause diarrhoea while thiazolidinediones may increase LDL-cholesterol levels. Weight gain and hypoglycemia are common side effects of insulin [13, 14].

Yoga based life style intervention; an innovative form of psycho-physical activity with yoga based stress management strategies has become more useful today than

ever. It can be considered the best intervention for community-based management programs in tackling the burden of type 2 diabetes in India,[15] as it has already shown its efficacy in different domains of T2DM [16].

Two recent meta- analyses have concluded that yoga is beneficial for T2DM and can help reduced both FBS and HbA1C. They concluded that beneficial effects of yoga as an add-on intervention to standard treatment in comparison to standard treatment were observed for FBS [Standardized Mean Difference (SMD) -1.40, 95%CI -1.90 to -0.90, p<0.00001]; PPBS [SMD -0.91, 95%CI -1.34 to -0.48, p<0.0001] as well as HBA1C [SMD -0.64, 95%CI -0.97 to -0.30, p<0.0002]. With this available evidence, yoga can be considered as add-on intervention for management of diabetes [17, 18]. Evidence from randomized controlled trials (RCT's) have already shown the usefulness, though expensive nature of carrying out lifestyle intervention programs [19-21].

The study has been undertaken with the aim to study the effectiveness of yoga intervention on glycemic parameters like Blood Glucose both Fating and Post Prandial (FBG, PPG), Glycosylated haemoglobin (HbA1c) and anthropometry parameters in patients of T2DM. Three trials from India, in which a total of 310 patients were randomised, all showed a positive but statistically non-significant impact of yoga on glycemic control [22, 23, 24]. Awareness in following alternative therapies for managing diseases such as yoga is increasing. Trials have shown that can reduce FBG, PPG and HbA1c, as well as improve the lipid levels and quality of life of T2DM patients. However many studies have been conducted for a short duration of time and on a smaller sample size. Other studies applied a non-randomized study design that could affect the final outcomes [24-27].

Although there is a vast literature on the health benefits of yoga, only a small section is devoted to its effects on diabetic population in India. However, few clinical trials done in India suggest that yoga can be improve glycemic control [16]. In view of these studies, the present study was undertaken to study the effect of yoga intervention on glycemic parameters in type 2 Diabetic subjects.

Methodology

A hospital based prospective randomized trial was conducted on 104 patients of confirmed cases of type 2 Diabetes mellitus (age group 30-65 of either gender) in Department of Biochemistry and Department of Medicine, RUHS College of Medical Sciences after obtaining institutional Ethical Committee Clearance and written informed consent from all subjects. Inclusion Criteria for the study was Confirmed cases of T2DM and patients on hypoglycemic drugs according to American Diabetes Association(ADA)/ European Association of Study of Diabetes criteria(EASD) (FBG ≥126mg/dl and PPG ≥200 mg/dl, HbA_{1c} ≥6.5) [29]. The duration of diabetes was 2 to 8 years. Patients of acute and chronic infections, Connective tissue disease, Seriously ill patients, Patients with claims for myalgia, myositis and myopathy, Cancer, Pulmonary tuberculosis, Haemolytic disease, Chronic Obstructive Pulmonary Disease (COPD), Bronchial Asthma, Rheumatoid arthritis, Variation in treatment redimes during study follow-up period were excluded from the study. All patients were introduced about standard lifestyle measures [30].

Intervention

Subjects were randomized in two groups viz. Group 1- Patients of T2DM without intervention of Yoga(n=52) which acted as control and Group 2- Patients of T2DM with intervention of Yoga(n=52). (Approximately 40 min yoga pattern, minimum five times a week over a period of six months). Both the groups were on conventional treatment.

Table 1: Schedule of yoga asanas followed during 6 months duration:

	Rounds		Approximate Duration (Secs)
Prayer	Omkar 3 times		60
Trikonasana	6		60
Katichakrasana	6		60
Surya Namaskaras	9		90 sec each
Arthamatsyendrasana	Each side 90 secx2		180x2
Pavanamuktasana	4		90 sec each
Bhujangasana	2		90x2
Dhanurasana	2		90x2
Padachakrasana	Clock/anti clock 15 +15		120
Pranayamas:	i) Rechaka, Puraka	20 units*	60
	ii) Bhastrika	5 units**	60
	iii) Nadi Shodhana	1-24x2	90
Prashantha Asana/Meditation	-		10mins

*1-inhale, 1-Exhale = 1 unit

** 4 Expulsions, 1 Long Breath = 1 unit

Each asana was hold for 30-60 seconds and some of them repeated multiple times during a session. All the participants were trained by professional certified yoga instructor. Yoga CD was given for all enrolled subjects of yoga group. Patients were being motivated and monitored telephonically and personally.

After an overnight fast of 10-12 hrs, venous blood samples were collected from antecubital vein puncture by using aseptic techniques. 6 ml blood was drawn in plain vacutainers and 3 ml blood in EDTA coated vacutainers. Anthropometric parameters such as height, weight, waist, hip circumference, systolic blood pressure (SBP) and diastolic blood pressure (DBP) were noted. The standard BP were measured three times & mean BP was calculated. Body Mass Index (BMI) was calculated by dividing weight in kilograms by height in meters square [31]. FBG, PPG and

HbA1c were estimated at Baseline and after 6 months in both group using commercially available kits on fully automated analyzer. The results were presented as percentage, mean and standard deviation (SD). Paired student t-test was used to estimate difference in means, calculate before and after intervention. The inter group continuous variables were compared using unpaired student's t test, paired student's t test. Unpaired t test was used to find out significance of difference in mean values in both group. Pearson's correlation analysis was performed to study the association between parameters. Statistical Package for Social Science SPSS version 22.0 software for windows was used, with P<0.05 considered as statistically significant.

Results

A total of 104 of type 2 Diabetics subjects were enrolled in the study out of these 57 (55%) were male and 47 (45%) were female. In non yoga group 25 were male and 27 were female and in yoga group 32 were male and 20 were female.

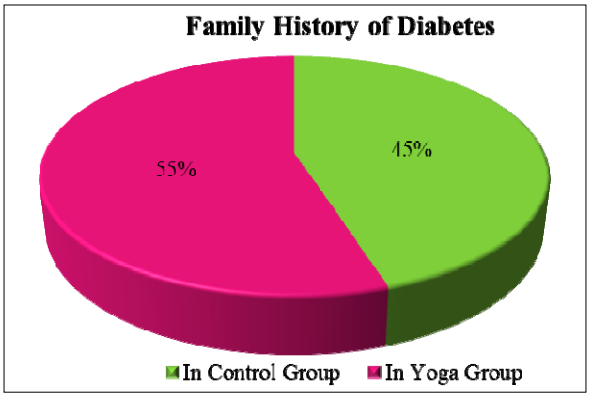

Fig 1: Family history of Diabetes

Table 2: Distribution of Diseases, Socio-Economic Status and Family History of Diabetes in 104 Patients in the Study

	In Control Group	In Yoga Group
Accompanied diseases		
Hypertension	8	9
Coronary Heart Disease	2	1
Psychologic Problems (Including Anxiety, Stress, Depression and Insomnia)	10	12
Tention Headache	8	5
Backache	2	3
Osteoarthritis	3	2
Overweight & Obesity	36	34
Peptic ulcer/Constipation	6	4
Miscellaneous	7	4
Socio-Economic Status (SES)		
Total Score		
26-29	17	15
16-25	18	20
11-15	8	8
5-10	7	8
< 5	2	1
Family History of Diabetes	18	22

Table 3: Anthropometric & Biochemical Parameters in Control and Yoga Group in Type 2 Diabetes

	Control (n=52)		Yoga (n=52)	
Parameters	**Baseline (Mean± SD)**	**After 6 months (Mean± SD)**	**Baseline (Mean± SD)**	**After 6 months (Mean± SD)**
BMI (kg/m2)	28.15±3.2	28.02±3.1	28.14 ± 3.2	25.11±3.4**
WHR	0.99±.06	0.99±0.05	0.98±0.06	0.92±.06**
Systolic Blood Pressure (mmHg)	140.46±23.05	145.67±19.27*	141.46±23.05	121.88±11.9**
Diastolic Blood Pressure (mmHg)	82.82±6.61	83.04±8.02	83.82±6.62	76.53±6.97**
Blood Glucose (Fasting) (mg/dl)	164±47	156±45	183±53	130 ±36**
Blood glucose (Post Prandial) (mg/dl)	253±65	225±65	234±62	174±66**
HbA1c (%)	7.69±4.17	9.20±2.30*	8.29±2.13	7.11±1.5**

**highly Significant *Significant

The Baseline characteristics of patients are given in table 3. The mean BMI in yoga group and non yoga group at Baseline was 28.15±3.2 and 28.14±3.2 respectively. This indicates that majority of participants of the study were over-weight. The waist hip ratio (WHR) in nonyoga and yoga group was found to be 0.99±0.06 and 0.98±0.06 respectively, indicating that participants fall under high risk category. The mean of 141.46/83.82 mmHg Bp for yoga and 140.46/82.82 mmHg Bp for non-yoga group indicates that the participants fall under the high risk category.

On the comparison in intragroup, at the end of 6 months HbA1c levels in T2DM were found to be significantly increased in non yoga group when compared to the baseline (7.69±4.17<9.20±2.30). Decrease in FBG and PPG was observed in nonyoga group after six months but it was statistically non significant. No change is observed in BMI, WHR and BP after six months as compared to baseline.

In the yoga group a statistically significant decrease in blood glucose (F and PP) was observed after practice of yoga asana for 6 months when compared to non yoga group. A similar trend were observed in HbA1c levels which is found to be statistically significant. BMI, WHR, SBP, DBP levels

were decreased in yoga group and it was statistically significant. A significant decreased in SBP, DBP were observed in yoga group after practice of yogasans at the end of six months.

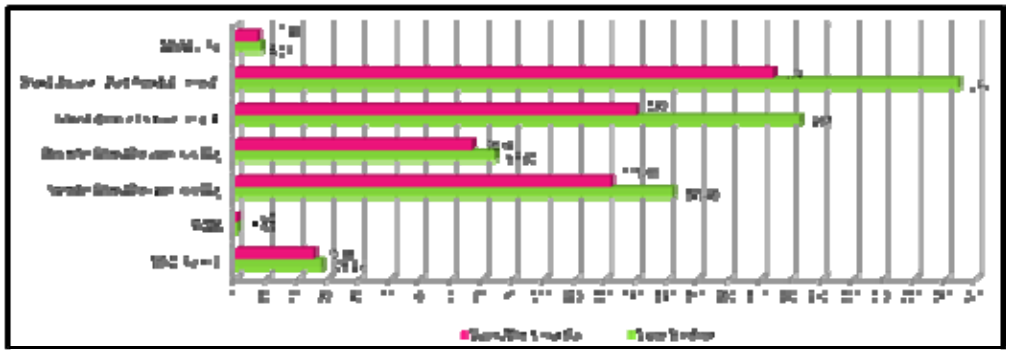

Fig 2: Intra group Comparison of yoga patients at baseline and after 6 months

Figure 2 shows the significant improvement in body Mass Index. Waist Circumference and systolic blood pressure was observed in diabetics of yoga group as compared t baseline to the follow-up (p-value<0.05). A significant decrease in Blood glucose (F&PP) and HbA1c was also observed (p-value<0.05).

Discussion

The present study was undertaken to study the effect of practicing yoga in patients with T2DM. The effect of exercise on glucose uptake lasts up to 48 hrs.[32,33,34] Therefore, asanas-based yoga should be recommended daily, or at least every other day, to achieve the desired effect on blood glucose. In our study the patients of yoga group practiced yoga approximately 40 min yoga pattern, minimum five times a week over a period of six months.

Studies revealed that prevention of obesity in adults may prevent half of the cases of T2DM. It is estimated that in 60-90% of cases, disease development and progression occurring by their overweight and obesity [35]. A decrease in BMI & WHR has been found in the present study in yoga group after 6 months of yoga practice as compared to control group which is concordance with Sahay *et al.*, who also reported an association in lean body mass & reduction in skin fold thickness [16]. Yoga helps in redistribution of body fat and reduction in central obesity which leads to insulin resistance [36]. Yoga is also known to regulate eating patterns, and its potential utility in the management of eating disorders has been advocated [37]. A significantly decrease in BMI from 26.4±6.6 to 25.6±6.2 in patients of T2 DM after yoga intervention of 12 weeks has been reported [38]. A study by Braunstein stated that BMI and physical inactivity are independent predictors of incident of diabetes [39]. Adamu G Bakari *et al*. found positive but non significant correlation between blood sugar and BMI among female subjects (r=0.1520, P>0.05). In the males however, there was no correlation between these variables (r=0.0395, p>0.5) [40]. As would be predicted, women who subsequently developed diabetes had a higher mean BMI, were more likely to have a family history of diabetes in a first degree relative and were more likely to have a history of hypertension or hyperlipidemia [41].

In our study a significant decrease in SBP, DBP was observed in yoga group after practice of yoga asans at the end of six months as compared to control group. Wycherley TP *et al*. studied 16 patients of T2DM with diet restriction and 13 patients of T2DM with diet restriction and exercise 12 weeks and found in both interventions reduced body weight, waist circumference, BP, HbA1c, glucose, insulin resistance, lipids and MDA, and increased urinary nitrite/nitrate ratio [42].

Our results show that practice of yoga for 6 months significantly decreased (FBG& PPG) and HbA1C levels in Type 2 diabetics. The mechanism of the antiglycaemic activity of yoga exercise is yet to be described. A mechanism of neurohormonal modulation involving insulin and glucagon activity remains a possibility [5].

Sahay BK *et al*., reported significant reduction in FBG & PPG after 3 months of yoga intervention in patients of T2DM. They reported an improvement in insulin sensitivity and decrease in insulin resistance in subjects practicing yoga [16]. Manjunatha *et al*. studied the effect of four sets of asanas in random order for five consecutive days leads to an increased sensitivity of the beta cells of pancreas to glucose signals [43]. A study of Mikus *et al*. stated that short term daily exercise reduces post prandial plasma glucose (PPG) and glycemia variability in T2DM patients [44]. Boule *et al*. found intense of exercise showed remarkable improvements in blood glucose and reductions in HbA1c [45]. A study by Connie *et al*. stated that increased physical activity significantly related to lower blood glucose and greater insulin sensitivity [46].

The beneficial effect of yoga in T2DM has been attributed to increased insulin sensitivity at target tissues which decrease insulin resistance and consequently increases peripheral utilization of glucose. The dynamic stretching of the body during yoga asana is postulated to rejuvenate pancreatic cells, increase insulin secretion and hence correct the impaired insulin secretion in chronic diabetes [16].

Surya namaskar improves metabolic function, helping in utilizing excess glucose while toning up the musculoskeletal system. Trikonasana, Katichakrasana, Arthmatsyendrasana, Pavanamuktasana, Bhujangasana, Dhanurasana, Padachakrasana are stimulate intra-abdominal organs such as liver and pancreas and harmonizing psycho-neuro-endocrine function. Pranayamas contribute toward a sense of calmness that enhance inherent healing potentials [47].

Numerous drugs are used to control blood glucose levels, however these drugs have their own side effects. There is a need to develop healthy lifestyle habits and preventive & management strategies for T2DM. Yoga may prove to be an optimal prevention and treatment option with no significant negative side effects.

The results of the present study demonstrate that yoga is

effective in reducing blood glucose levels. Yoga proves to be a viable treatment for T2DM and patients should maintain adherence to yoga to decrease the dosage of oral hypoglycaemic drugs/insulin and also delay progression of disease process.

Conclusion

Regular yogic asanas practices produce positive changes on anthropometric, physiological & biochemical variables of T2DM patients. Perception of yogic asana practice is relevant in T2 DM as it results in significant positive clinical outcome. Yoga can be considered as cost effective & holistic intervention in improving BMI & glycemic parameters in T2DM.

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