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AN INVESTIGATION INTO THE ACUTE AND LONG-TERM EFFECTS OF SELECTED YOGIC POSTURES ON FASTING AND POSTPRANDIAL GLYCEMIA AND INSULINEMIA IN HEALTHY YOUNG SUBJECTS

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Abstract : The study was conducted to examine the hypothesis that yogasanas help in the treatment of diabetes mellitus by releasing insulin from the pancreas. Twenty healthy young voluntees (17 male, 3 female; age 19–31 years) participated in the study. Each volunteer performed four sets of asanas in random order for 5 consecutive days each with a 2-day gap between consecutive sets of asanas. The four sets of asanas were : (I) *dhanurasana* + *matsyendrasana*, (II) *halasana* + *vajrasana*, (III) *naukasana* + *bhujangasana*, and (IV) *setubandhasana* + *pavanamuktasana*. Blood samples were collected on days 4 and 5 of each set of asanas for measurement of glucose and insulin levels before the asanas, within 10 min after performing the asanas, and 30 min after ingestion of 75 g glucose, which in turn was ingested immediately after the second blood sample. A standard 75 g oral glucose tolerance test (OGTT) was also done before and after the study. On the days of the pre-study or post-study OGTT, no asanas were done. The serum insulin levels after the asanas were lower ($P<0.05$) than those before the asanas. However, the serum insulin level 0.5 h after the post-asana oral 75 g-glucose challenge was higher ($P<0.05$) in Set IV than the 0.5 h postprandial insulin level in the pre-study OGTT; the same trend was observed in other sets as well although statistically not significant. The observations suggest that the performance of asanas led to increased sensitivity of the B cells of pancreas to the glucose signal. The increased sensitivity seems to be a sustained change resulting from a progressive long-term effect of asanas. The study is significant in that it has for the first time attempted to probe the mechanism by which yogasanas help diabetes mellitus.

Key words : yoga insulin diabetes mellitus

INTRODUCTION

There are several studies suggesting a place for yoga in the management of diabetes mellitus (1–5). While details of the yogic intervention may differ widely, asanas

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(physical postures) are invariably at least one component of the intervention. Some yogic practitioners claim that a few selected asanas that involve twisting or folding of the abdomen are particularly beneficial in diabetes because they release insulin by compressing the pancreas (6). The present study was designed to examine this hypothesis, and to the best of our knowledge, is the first study to do so. In the present study, serum concentrations of insulin measured 'immediately' after the asanas, and the insulinemic response to an oral glucose challenge after asanas was also evaluated in healthy young human subjects. In addition to these acute responses, the long-term effect of performing asanas for 4 weeks on glucose tolerance was also investigated.

METHODS

The study was done on 20 healthy young volunteers (17 male, 3 female; age 19–31 year). All of them were non-smokers and non-alcoholics, and none of the female volunteers was pregnant.

During the 4-week study period, every volunteer performed the following sets of asanas for 5 consecutive mornings each.

Set I : *Dhanurasana* (Bow pose) and *Ardhamatsyendrasana* (Half spinal twist).

Set II : *Halasana* (Plough pose) and *Vajrasana* (Thunderbolt pose).

Set III : *Naukasana* (Boat pose) and *Bhujangasana* (Cobra pose).

Set IV : *Setubandhasana* (Bridge pose) and *Pavanmuktasana* (Wind releasing pose).

The asanas of sets I – III were found to be effective in reducing fasting and postprandial glucose in diabetes by Sahay (1). The asanas in set IV are *not* specifically advised for diabetics, and served as controls.

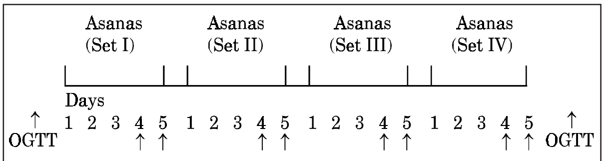
The volunteer performed a set of asanas from Monday through Friday. After a 2-day gap (Saturday and Sunday), he/she started with the next set of asanas. The sequence of the four sets of asanas was randomized.

Blood samples were collected on days 4 and 5 (Thursday and Friday) of each set of asanas for measurement of glucose and insulin at the following time points :

(a) before the asanas

(b) within 10 min of finishing with the asanas.

Since the subject came after an overnight fast for asanas, both (a) and (b) were fasting samples. After collecting sample (b), the subject was given a drink containing 75 g glucose dissolved in 300 mL water. A third blood sample was collected 30 min after ingestion of the glucose drink. An oral glucose tolerance test (OGTT) was done 2–3 days before and after the 4-week study. The experimental design has been shown below.



Days 1–5, Monday – Friday, ↑, Blood samples; OGTT, Oral glucose tolerance test.

The protocol – On each of the days that the volunteer came for asanas, the sequence of events was as follows :

Fasting blood sample*

Breathing exercises : 5 min

(a) Dog breathing

(b) Tiger breathing

Stretching exercises : 10 min

Tadasana (Palm tree pose)

Neck rolls

Shoulder movements

Arm rotation

Elbow movements

Finger movements

Waist bends

Knee rotation

Ankle movements

Asanas as per the Set : 10 min

Each asanas for 30 sec at a time thrice with an interval of 1 min between the asanas.

Shavasana (Corpse pose) : 5 min

Blood sample within 10 min*

75 g glucose drink*

Blood sample 30 min after the glucose drink*

*Only on days 4 and 5 of each set

Oral glucose tolerance test – After having been on an unrestricted carbohydrate diet for at least 3 days, the subject reported after an overnight fast. The patient was made to sit peacefully in a comfortable environment for 30 min, and then a venous blood sample (fasting) was collected. Then 75 g glucose was dissolved in 300 mL of refrigerated cold water, lemon juice added to it, and the drink administered to the subject orally. Thereafter venous blood samples were drawn at 30-min intervals till 2 h after ingestion of the drink.

Serum glucose – Serum concentration of glucose was determined by the glucose oxidase method using kits obtained from Randox Laboratories Ltd., Antrim, U.K. The intra-assay and inter-assay coefficients of variation for glucose were 2.1% and 4.0%, respectively.

Serum insulin – Serum concentration of insulin was determined by radioimmunoassay using kits obtained from Medicorp, Canada. The intra-assay and inter-assay coefficients of variation for insulin were 3.6% and 5.6%, respectively.

Estimates of insulin sensitivity – Indices of insulin sensitivity were calculated using formulae for (i) homeostatic model assessment (HOMA) for insulin resistance (7), and (ii) quantitative insulin sensitivity check index (QUICKI) (8).

Data analysis – The glucose and insulin values before the asanas were compared with those after the asanas. The 0.5 h postprandial glucose and insulin after the asanas were compared with the 0.5 h postprandial glucose and insulin in the pre-study standard OGTT. All these comparisons were made by Student's *t*-test. The comparisons of the insulin values have been made for log-transformed values.

The Ethics Committee of All India Institute of Medical Sciences approved the study. Volunteers were enrolled in the study after they had given their informed written consent for participation.

RESULTS

The characteristics of the subjects have been summarized in Table I. The serum concentrations of glucose and insulin before, and immediately after asanas have been given in Table II. There was no significant difference between the serum glucose levels before and immediately after the asanas. Further, the serum glucose 0.5 h after an oral 75 g-glucose challenge in case of the four sets of asanas was not significantly different from the 0.5 h postprandial plasma glucose level (mean ± SD, 140.1 ± 36.7 mg/dL) in the standard OGTT done before the study. However, the serum insulin levels after the asanas were significantly ($P<0.05$) lower than those before the asanas. Further, the serum insulin 0.5 h after the oral 75 g-glucose challenge in Set IV was significantly higher than the 0.5 h postprandial insulin level (mean ± SD, 635.7 ± 357.2 picomoles/L) in the standard OGTT done before the study. The trend was similar in Sets I, II and III, but the differences were statistically not significant.

TABLE I: Characteristics of the subjects.

Characteristic	*Value (mean±SD)*
Age (years)	23.8±4.0
Height (m)	1.6±0.05
Weight (kg)	57.2±6.3
BMI (kg/m^2)	21.2±1.6

The results of standard OGTT done before and after the study have been given in Table III. Comparison of corresponding pre-study and post-study levels revealed a significant ($P<0.05$) difference only in case of the 0.5 h insulin levels. However, there was no significant change in area under the 2-h insulin curve (AUC).

In order to examine whether the changes observed in Table II were specific to the asanas in the various sets, or had evolved over 4 week during the study, the same data has been analysed as a function of time from week 1 through week 4 as shown in Table IV. The trend towards a higher insulin level 0.5 h after the post-asana 75-g glucose challenge, as compared to the corresponding level before the study first appears in week 2. This difference is significant ($P<0.05$) in week 3, and the trend persists in week 4.

As compared with the pre-study OGTT data, there was no significant change in HOMA and QUICKI estimates of insulin sensitivity during the study whether we consider individual sets of asanas, or the weekly progression, or the post-study OGTT.

TABLE II: Glucose and insulin levels before and after various sets of asanas.

Asanas	*Plasma glucose (mg/dL)*			*Serum insulin (picomoles/L)*		
	Before asanas	*After asanas*	*After glucose*	*Before asanas*	*After asanas*	*After glucose*
Set I	83.9±13.2	81.7±12.4	142.1±23.1	139.0±37.9	125.1±35.6*	820.3±427.5
Set II	81.2±13.9	79.3±15.2	142.6±25.9	156.6±82.6	132.1±35.6*	814.5±368.1
Set III	83.8±18.6	83.0±15.3	142.9±25.8	144.4±54.0	123.8±37.9*	833.8±472.4
Set IV	76.4±15.1	74.7±16.4	136.3±27.9	150.8±67.0	136.4±56.4*	868.0±395.5$^+$

*$P<0.05$, as compared to 'Before asanas'.
$^+$$P<0.05$, as compared to 0.5 h value in Pre-study OGTT (Table III).
Values are shown as means±SD.

TABLE III : Oral glucose tolerance before and after the study.

	Plasma glucose (mg/dL)		*Serum insulin (picomoles/L)*	
	Pre-study	*Post-study*	*Pre-study*	*Post-study*
Fasting	83.3±16.2	82.7±13.4	152.9±61.3	153.8±63.6
0.5 h	140.1±36.7	146.6±27.2	635.7±357.2	787.4±402.4*
1.0 h	128.8±29.4	120.2±21.6	606.9±224.1	661.7±408.1
1.5 h	107.0±30.8	103.0±29.7	543.6±331.2	518.6±242.5
2.0 h	100.0±24.4	103.8±23.0	371.5±175.1	458.1±211.9

*P<0.05, as compared to 'Pre-study'.
Values are shown as means±SD.

TABLE IV : Sequential glucose and insulin levels before and after asanas.

Period of the study	*Plasma glucose (mg/dL)*			*Serum insulin (picomoles/L)*		
	Before asanas	*After asanas*	*After glucose*	*Before asanas*	*After asanas*	*After glucose*
Week 1	79.6±15.6	76.5±13.3	131.8±21.8	165.1±93.0	141.6±54.9	773.6±359.4
Week 2	77.2±16.5	74.2±16.9	138.2±24.7	147.2±42.6	127.5±36.8	855.5±434.6
Week 3	83.0±15.2	81.4±13.6	147.0±28.3	156.0±49.1	120.8±36.8	841.1±363.0*
Week 4	85.6±13.8	86.5±13.7	146.9±25.1	140.7±53.8	127.5±36.1	866.3±494.4

*P<0.05, as compared to 0.5 h value in Pre-study OGTT (Table III).
Values are shown as means±SD.

DISCUSSION

Since the serum insulin levels within 10 min of performing a variety of asanas were not higher than those before the asanas, there is no evidence for release of insulin from the pancreas as a result of performing the asanas. On the contrary, the insulin levels after the asanas were significantly lower after the asanas than before the asanas (Table II). Further, postprandial serum insulin 0.5 h after ingestion of 75 g glucose was higher after the asanas than the corresponding value in the OGTT performed before any set of asanas had been done. This difference was statistically significant only in Set IV, but the trend in other sets was also the same (Table II). These observations suggest that the performance of asanas led to increased sensitivity of the B cells of pancreas to the glucose signal. Performance of asanas in the fasting state was presumably accompanied by steady and accelerated utilization of glucose, but serum glucose did not fall significantly after the asanas. The reason possibly was that the B cells responded to accelerated glucose utilization with prompt decrease in insulin release. On the other hand, administration of 75 g glucose led to a prompt increase in insulin release in amounts greater than under similar circumstances before the subject had been initiated into any asanas. Thus the increased sensitivity of B cells to glucose which we have hypothesized seems to work both ways, reducing insulin release briskly when glucose level tends to fall, and increasing insulin release sharply when glucose level tends to rise.

The next question which needs to be

answered is whether the increased sensitivity of B cells is the acute effect of performing asanas, or whether it is a sustained change resulting from a progressive long-term effect of asanas. The latter seems to be the case because the higher insulin level at 0.5 h is observed also in the post-study OGTT, a day on which no asanas were done. Further, the progressive development of the effect is revealed when the results are arranged sequentially in terms of time (Table IV). The 0.5 h postprandial insulin levels are higher than the corresponding pre-study OGTT value from wk 2 onwards, but not in wk 1. Since the sets of asanas were done in a random sequence, the effect seems to be due to the progressive build up of enhanced sensitivity of B cells irrespective of the asanas done rather than the specific effect of any set of asanas.

Thus, the results of the present study have challenged the explanation popular among yoga teachers that asanas help diabetes by releasing insulin. The study also suggests an alternative explanation in terms of the asanas enhancing the sensitivity of the B cells of the pancreas to the glucose signal. Although a variety of physical exercises are known to enhance the peripheral sensitivity to insulin (9), we have come across only one earlier study that has hinted at a change in the sensitivity of B cells as a result of a physical activity (10). Further studies are needed to examine how far the results of the present study are valid also for those having diabetes mellitus, specially because of the dramatic differences that have been reported earlier between diabetics and non-diabetics (11).

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