Original Article

Cardiac autonomic function in patients with diabetes improves with practice of comprehensive yogic breathing program

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ABSTRACT

Background: The aim of this study was to observe the effect comprehensive yogic breathing (Sudarshan Kriya Yoga [SKY] and Pranayam) had on cardiac autonomic functions in patients with diabetes. **Materials and Methods:** This is a prospective randomized controlled intervention trial. Cardiac autonomic functions were assessed in 64 diabetics. Patients were randomized into two groups, one group receiving standard therapy for diabetes and the other group receiving standard therapy for diabetes and comprehensive yogic breathing program. Standard therapy included dietary advice, brisk walking for 45 min daily, and administration of oral antidiabetic drugs. Comprehensive yogic breathing program was introduced to the participants through a course of 12 h spread over 3 days. It was an interactive session in which SKY, a rhythmic cyclical breathing, preceded by Pranayam is taught under the guidance of a certified teacher. Cardiac autonomic function tests were done before and after 6 months of intervention. **Results:** In the intervention group, after practicing the breathing techniques for 6 months, the improvement in sympathetic functions was statistically significant (*P* 0.04). The change in sympathetic functions in the standard therapy group was not significant (*P* 0.75).Parasympathetic functions did not show any significant change in either group. When both parasympathetic and sympathetic cardiac autonomic functions were considered, there was a trend toward improvement in patients following comprehensive yogic breathing program (*P* 0.06). In the standard therapy group, no change in cardiac autonomic functions was noted (*P* 0.99). **Conclusion:** Cardiac autonomic functions improved in patients with diabetes on standard treatment who followed the comprehensive yogic breathing program compared to patients who were on standard therapy alone.

Key words: Cardiac autonomic function, comprehensive yogic breathing, diabetes mellitus

Introduction

Although there is a vast literature on the health benefits of yoga, only a small section is devoted to its effects on diabetes. A few clinical trials suggest that yoga can improve glycemic control.[1-5] Yoga therapy has been associated with a multitude of benefits and few adverse effects according to a recent systematic review of the effects of yoga on physiological and clinical risk factors in adults with diabetes.[6] Most studies have not been performed under rigorous scientific conditions including use of randomized control design. Sudarshan Kriya Yoga (SKY) has shown to have a beneficial effect on glycemic control and lipid parameters in diabetes.[1]

Yogic breathing techniques have shown to have a beneficial effect on autonomic neuropathy.[7-14] There are no studies of effect of SKY on autonomic neuropathy.

The aim of the present study was to assess the effect of comprehensive yogic breathing program (Sudarshan Kriya

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and Pranayam) on cardiac autonomic functions in patients with diabetes mellitus.

Previous studies suggested that SKY may be useful in glycemic control in patients with diabetes.[1] There was a significant decrease in the fasting blood sugar, cholesterol, and triglycerides after practice of comprehensive yogic breathing for 4 months in patients with diabetes.[1] This finding suggests a promising potential for comprehensive yogic breathing as a complementary therapy in diabetes.

Yoga can be easily learned and practiced at any time on an individual basis, thus reducing common barriers to physical activity such as time conflicts and poor weather. Regular practice of Sudarshan Kriya has been found to be useful in improving the quality of life in patients with diabetes.[15] Yoga has been studied for controlling both the symptoms and the complications associated with diabetes mellitus.[3,4,16]

Materials and Methods

This study was a randomized controlled intervention trial. A total of 112 patients were told about the study and 64 patients gave an informed consent. A total of 64 patients attending the endocrine clinic of the All India Institute of Medical Sciences, New Delhi, during the period from March 2009 to August 2011, who were having HbA1c between 6% and 9%, following lifestyle modification (diabetic diet and brisk walking for 45 minutes per day) and on same dose of oral hypoglycemic agents for the past 6 months or more were included in the study.

All patients underwent a fundus examination and intraocular pressure testing before the autonomic function tests and patients with diabetic retinopathy, degenerative retinopathy, and glaucoma were excluded. Patients having uncontrolled hypertension, schizophrenia, bipolar disorder, diabetes type-1, coronary artery disease, overt nephropathy, and overt complications of diabetes were excluded.

This study was approved by the Institute Ethics committee. Patients who fulfilled the inclusion and exclusion criteria were told about the study and informed consent was taken from subjects who agreed to participate in the study.

Randomization was done by computer-generated numbers using the n Query advisor program. Patients were randomized into 2 groups: (1) The group which followed only the standard therapy for diabetes (Standard group). This group had 28 patients. The standard therapy included dietary advice, brisk walking for 45 minutes daily and oral antidiabetic drugs. (2) The other group (SKY group) underwent a comprehensive yogic breathing program in which they were taught SKY and Pranayam. This group continued the standard therapy as well. This group had 36 patients.

SKY is a breathing technique,[17,18] The process is introduced to the participants through a 22-24 h structured program called the art of living workshop spread out over 6 days. It can also be taught in a short course of 12 h over 3 days. This short course was used in the present study. Sudarshan Kriya is a rhythmic cyclic breathing of slow, medium, and fast cycles done 3 times in a count of 20, 40, 40 respectively. It is preceded by a 3-stage Pranayam in Ujjayi breath, Bhastrika: Rapid inhalation and exhalation; and brief chanting. These processes are practiced while sitting with the eyes closed and the awareness focused on breathing. This process ends with rest in a tranquil supine position.

It has to be learnt under guidance of a certified teacher. This course includes yogic movements and postures (asanas), relaxation practices, meditation, group processes, and discussion of stress-relieving principles.

Comprehensive yogic breathing program was a 3-day 12 h course in which the breathing techniques were taught. The group undergoing yogic breathing training was told to practice it every day and to attend weekly follow-up at the assigned centers. They were asked to fill a follow-up diary, in which they were marking the days on which they did breathing techniques at home and got it countersigned by a relative or attendant daily and by the yoga teacher each time they attended the weekly follow-up.

Patients underwent fasting plasma glucose (FBS), post prandial plasma glucose (PPBS), and glycated hemoglobin (HbA1C) at baseline and 3 and 6 months post randomization. Cardiac autonomic Function Tests (CAFT) were done at baseline and 6 months.

All 64 patients underwent standard battery of tests to assess cardiac autonomic function. Patients were told not to smoke and not to have coffee or tea 2 h before the test.

Cardiac autonomic functions were assessed by the following cardiac autonomic function tests[19]

1. Deep breathing test: The patient sat quietly and was instructed to breath smoothly, slowly, and deeply at 6 breath/min. (5 seconds inspiration and 5 seconds expiration), a rate which produces maximum variation of heart rate. Heart rate was measured from electrocardiogram Delta heart rate was the difference between maximal and minimal heart rate during inspiration and expiration, averaged for 6 cycles. E: I ratio was the ratio of longest

distance between two r waves (R-R interval) and shortest R-R interval, averaged over 6 cycles.
2. Valsalva maneuver: The subject sat quietly and blew into a mouth piece attached to a sphygmomanometer generating a pressure of 40 mm Hg for 15 s. At the end of 15 s, the pressure was released. Due care was taken to prevent deep breathing before and after the maneuver. Valsalva ratio was calculated from longest the R-R interval during phase IV to the shortest R-R interval during phaseII.
3. Sustained handgrip test: The baseline blood pressure (BP) was recorded in the subject. Then, the patients were asked to grip the handgrip dynamometer using maximum force with their dominant hands for a few seconds.The value was noted down and the procedure was repeated thrice. The maximum value of the 3 readings was considered as their maximal voluntary contraction (MVC). A mark was made on the dynamometer at 30% of MVC of the subject. The patient was then instructed that he/she had to maintain the grip on the dynamometer up to the mark for 4 min. After the patient had started, the BP was measured on the contra-lateral arm at 1st, 2nd, and 4th min. It was calculated by subtracting from their highest diastolic BP during the test to the baseline diastolic BP.
4. Cold pressor test: The baseline BP of the subject was recorded. The subjects were advised to immerse their hand in cold water of temperature 10°C up to the wrist for 1 min. The BP was taken just before the hand was taken out of the water. It was calculated by subtracting from the highest diastolic BP during the test to the baseline diastolic BP.
5. Lying to standing test: This test was conducted after 10 min of supine rest. Then the patient was told to stand within 3 s and BP and heart rate were recorded at baseline and at 2nd min. 30:15 ratios were calculated as the ratio between longest R-R at or around the 30th beat and shortest R-R at or around the 15th beat.

A few patients could not perform all the tests of cardiac autonomic function. Pre- and post-intervention heart rate changes during deep breath, 30:15 ratio, and E: I ratio were done in 60 subjects. Valsalva ratio could be done for 47 and 48 patients pre- and post-intervention. Sustained hand grip could be done for 59 patients pre- and post- intervention. Similarly, 58 and 59 subjects were able to perform cold presser test pre- and post-intervention respectively. Postural drop in systolic BP was done in 59 and 56 patients pre- and post-intervention.

Criteria for labeling patients with autonomic dysfunction

Criteria for normalcy were heart rate variation during deep breathing ≥15 beats/min, deep breathing expiratory to inspiratory R-R ratio ≥1.21, Valsalva ratio ≥1.21, sustained handgrip test ≥16 mm of mercury, cold pressor test ≥10, BP response to standing ≤10 mm of mercury, and 30:15 ratio R-R ratio on standing ≥1.04. An abnormal test was defined as the above parameters being <10 beats/min <1.21, <1.21, ≤10 mm of mercury, <10, ≥30 mm of mercury, and ≤1.0 respectively.[20]

Heart rate changes during deep breath test, E: I ratio, abnormal 30:15 beat ratio were taken as tests of parasympathetic nervous system (PNS) reactivity.

Maximum increase in BP during sustained hand grip, cold pressor test and postural drop in BP after 2 min of standing were taken as tests of sympathetic nervous system (SNS).

Patients were defined as having abnormality of PNS alone if ≥1 of the above 3 tests was abnormal, while rest of the tests were normal. Patients were defined as having abnormality of SNS alone I if ≥1 of above 3 tests was abnormal, while rest of the tests were normal. Valsalva ratio abnormality was taken as a test of combined (PNS and SNS) dysfunction.[20]

Patients were defined as having dysfunction of both PNS and SNS[20] if:
1. Valsalva ratio was abnormal.
2. The result of any test of PNS test was abnormal and that any test of SNS was borderline.
3. The result of any test of PNS and SNS was abnormal.

Patients were defined as having borderline dysfunction if both or either SNS or PNS revealed borderline abnormality and all other tests including Valsalva ratio were normal.

Statistics

Statistical analysis was done using Stata 11.1 for WINDOWS (Stata corp. 4905 Lakeway drive, college station, Texas 77845, USA). Data were presented as mean ± SD. Exact test for symmetry was applied for the distribution of autonomic dysfunction categories between two groups of patients. The distribution of clinical and biochemical parameters between the two groups was compared using one-way ANOVA as appropriate. Difference was considered significant at 2-tailed *P* value of ≤0.05.

Results

The age of patients ranged from 35 to 72 years with a mean age of 48 ± 2.2. The mean age of patients in the SKY group was 49.25 ± 10.02 years and in the standard group

was 47.53 ± 11.41 years. In SKY group, the mean duration of diabetes was 52.13 ± 43.35 months and in Standard therapy group, it was 42.07 ± 32.35 months (P = 0.30). Pre-intervention mean body mass index (BMI) for SKY group and standard therapy group were 25.05 ± 4.09 kg/cm^2 and 27.2 ± 3.42 kg/cm^2 (P = 0.03).

The change in glycemic control in the two groups post- and pre-intervention was comparable [Table 1]. When the individual tests were compared, P values were not significant.

Considering the results of the tests of the sympathetic cardiac autonomic functions [Table 2] in the group practicing breathing techniques, the sympathetic functions improved. In the SKY group, 24 patients and in the standard therapy group, 17 patients underwent the tests for sympathetic cardiac autonomic function. In the SKY group, out of 18 patients with abnormal sympathetic cardiac autonomic function tests pre-intervention, 6 (1 + 5) patients improved after practicing breathing techniques for 6 months. This improvement in sympathetic functions was statistically significant (P 0.04).The change in sympathetic functions in the standard therapy group was not significant (P 0.75).

Thirty-three patients in the SKY group and 24 patients in the standard therapy group were able to perform the tests of parasympathetic CAFT. In the SKY group, out of 9 patients with abnormal parasympathetic cardiac autonomic function tests pre-intervention, 6 improved post-intervention. The change in parasympathetic CAFT in the SKY group was not significant (P 0.46). In the standard therapy group out of 8 patients with abnormal parasympathetic cardiac autonomic functions pre-intervention, 5 improved post-intervention. This change was also not significant (P 0.70).

Table 3 shows the changes in cardiac autonomic function tests in the SKY group. In the SKY group, out of 23 patients pre-intervention, none had normal cardiac autonomic function test, but after practicing breathing techniques, 5 patients improved to normal cardiac autonomic functions. When both PNS and SNS functions were considered (P 0.06), the pattern of change is toward improvement in the group following the comprehensive yogic breathing program.

In the Standard therapy group, 1 patient who had normal CAFT progressed to borderline dysfunction. In Standard therapy group, out of 19 patients, none had normal CAFT

Table 1: Change in parameters of glycemic control in both groups

Tests	SKY group (*n*=36)			Standard therapy group (*n*=28)			Change between both groups		
	Pre-I	Post-I	*P*	Pre-I	Post-I	*P*	Pre-I	Post-I	*P*
FBS	137.38±40.57	142.08±34.05	0.42	134.14±27.43	138.96±31.78	0.41	−4.69±35.00	−4.82±30.60	0.72
PPBS	194.19±59.01	189.08±53.66	0.52	179.14±47.07	185.78±45.98	0.52	5.11±47.10	−6.64±53.90	0.38
HbA1C	7.47±1.90	7.54±1.25	0.78	6.92±1.21	7.32±1.38	0.14	−069±1.53	−0.39±1.37	0.90

n: Number of subjects, Pre-I: Pre intervention, Post-I: Post intervention, *P*: Probability, SKY: Sudarshan Kriya yoga group, FBS: Fasting blood sugar, PPBS: Post prandial blood sugar, HbA1C: Glycated hemoglobin

Table 2: Change in sympathetic cardiac autonomic functions in both groups

Pre intervention status *n*=24	Post intervention status (SKY)			Pre intervention status *n*=17	Post intervention status (standard therapy)		
	Normal	BL	Abnormal		Normal	BL	Abnormal
Normal (*n*=1)	0	1	0	Normal-(*n*=1)	0	1	0
BL (*n*=5)	4	1	0	BL-(*n*=2)	1	1	0
Abnormal (*n*=18)	1	5	12	Abnormal-(*n*=14)	0	2	12
Total (*n*=24)	5	7	12	Total-(*n*=17)	1	4	12
		P=0.04				*P*=0.75	

n: Number of subjects, SKY: Sudarshan Kriya Yoga group, BL: Border line, *P:* Probability

Table 3: Changes in cardiac autonomic function tests in Sudarshan Kriya Yoga group

Pre-intervention status (*n*=23)-categories of dysfunction	Post-intervention status				
	Normal	Parasympathetic alone	Sympathetic alone	Both dysfunction	Borderline
Normal (*n*=0)	0	0	0	0	0
Parasympathetic alone (*n*=1)	0	0	0	0	1
Sympathetic alone (*n*=5)	1	0	3	0	1
Both dysfunction (*n*=13)	1	0	3	8	1
Borderline (*n*=4)	3	0	0	0	1
Total (*n*=23)	5	0	6	8	4

n: Number of subjects, *P*: Probability, *P*=0.06

after 6 months. Table 4 shows that the change in standard therapy group is not significant (*P* 0.99).

Discussion

Yoga is practiced worldwide for its health benefits, including physical fitness, relaxation, and awareness of self. There are few studies which show the beneficial effects of Yoga on diabetes[1-4] In the study by Agte and Tarwadi, FBS was significantly lowered from 144 mg/dl to 119 mg/dl ($t = 3.72$, $P < 0.001$) after practice of SKY for 4 months,[1] though the change in HbA1c was not statistically significant. In another study, changes in blood glucose and glucose tolerance by oral glucose tolerance test (OGTT) after 40 days of yoga therapy in 149 non-insulin-dependent diabetics were investigated.[2] The response to yoga in these subjects was categorized according to a severity scale index based on area index total under the OGTT curve. One hundred and four patients showed a fair to good response to the yoga therapy.

In a randomized controlled trial, there was a small fall in HbA1c in the yoga group (29 type 2 diabetic patients) which was not sustained 6 months later.[21]

Ours was a randomized control study. There were 28 patients in the Standard therapy group and 36 patients in SKY group. The change in HbA1c between the two groups pre-intervention was − 069 ± 1.53 and post-intervention was − 0.39 ± 1.37 ($P = 0.90$). There was no significant change in glycemic parameters between the two groups after randomization.

SKY and Pranayam have shown to have beneficial effects on diabetes and quality of life in these patients. In an open preliminary study, there was a significant decrease in fasting blood sugar, cholesterol, and triglycerides after the practice of SKY for 4 months.[1] In another randomized controlled intervention trial after practice of SKY for 3 months, there was a significant improvement in the quality of life in the group practicing SKY in addition to standard treatment of diabetes compared with the group that was following the standard treatment alone.[20]

Autonomic neuropathy is associated with a lot of morbidity and mortality like sudden cardiac death in diabetes. Once autonomic neuropathy sets in, the treatment is basically symptomatic. Few studies have shown beneficial effects of Yoga on autonomic functions.[7-14] Unilateral forced breathing techniques have been shown to have beneficial effect on autonomic abnormalities.[7] Khanam *et al*.[8] have shown reduction in sympathetic reactivity and no effect on parasympathetic reactivity following comprehensive yogic lifestyle change program in patients with asthma. There was improvement in pulmonary ventilation by way of relaxation of voluntary inspiratory and expiratory muscles reflected in improvement in forced expiratory volume and peek expiratory flow rate. Yogic breathing has shown to have a beneficial effect on essential hypertension.[9] Three months of Pranayam training in young volunteers was associated with blunted sympathetic and enhanced parasympathetic activity.[10] Taneja *et al*.[11] also showed the beneficial effect of yoga on diarrhea-predominant irritable bowel syndrome. Yoga has been shown to have a role as adjuvant therapy in the management of autonomic dysfunction in patients with refractory epilepsy.[12] A recent study has shown yoga to have a positive effect on Heart rate variability.[13] Yoga has found to be beneficial in modifying cardiovascular functions in diabetics.[14]

We have conducted a randomized trial in which cardiac autonomic function tests were done pre- and post-intervention. In the SKY group, the sympathetic functions improved significantly (*P* 0.04). The change in sympathetic functions in the standard therapy group was not significant (*P* 0.75). Parasympathetic functions did not show any significant change in either group. When the changes in both sympathetic and parasympathetic functions were assessed together, patients in the comprehensive yogic breathing group had shown improvement in their cardiac autonomic function tests (*P* 0.06) as compared to the Standard group (*P* 0.99). This improvement was independent of glycemic control.

The strength of our study is that it is the first randomized control trial to see the effect of comprehensive yogic breathing in improving cardiac autonomic functions in

Table 4: Changes in cardiac autonomic function tests in standard therapy group

Pre-intervention status (*n*=19)-categories of dysfunction	Post-intervention status				
	Normal	Parasympathetic alone	Sympathetic alone	Both dysfunction	Borderline
Normal (*n*=1)	0	0	0	0	1
Parasympathetic alone (*n*=1)	0	0	0	1	0
Sympathetic alone (*n*=6)	0	0	4	1	1
Both dysfunction (*n*=9)	0	0	2	7	0
Borderline (*n*=2)	0	1	0	0	1
Total (*n*=19)	0	1	6	9	3

n: Number of subjects, *P*: Probability, *P*=0.99

patients with diabetes mellitus type 2. Since compliance was a major factor, we selected patients from near by who consented for follow-up. We ensured compliance by providing them a follow-up diary. They had to get the diary signed daily by a relative after finishing the short yogic breathing exercise at home. Their diary was reviewed weekly by yoga instructor at the weekly follow-up center.

The limitation of our study is that the sample size was small. Therefore, to confirm the benefit, a larger sample size needs to be studied. Secondly, at baseline, the BMI in the two groups was not comparable which could also affect the analysis.

If we can find a technique which can prevent or slow down the progress of cardiac autonomic dysfunctions, it would be very beneficial not only in diabetic autonomic neuropathy but also in other diseases which involve derangement of autonomic function. Since in this study, comprehensive yogic breathing program has shown a role in delaying progression of cardiac autonomic dysfunctions in patients with diabetes mellitus, it holds promise and needs to be further studied.

Conclusion

Cardiac autonomic functions improved in patients with diabetes on standard treatment who followed the comprehensive yogic breathing program compared to patients who were on standard therapy alone.

The sympathetic functions improved in the patients of SKY group which is statistically significant (*P* 0.04) as compared to Standard therapy group (*P* 0.75). This improvement was independent of the glycemic control. When both parasympathetic and sympathetic cardiac autonomic function tests were considered, there was a pattern of improvement in the group following the comprehensive yogic breathing program (*P* 0.06).

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References

1. Agte VV, Tarwadi K. Sudarshan kriya yoga for treating type 2 diabetes: A preliminary study. Altern Complement Ther 2004;10:220-2.
2. Jain SC, Uppal A, Bhatnagar SO, Talukdar B. A study of response pattern of non-insulin dependent diabetics to yoga therapy. Diabetes Res Clin Pract 1993;19:69-74.
3. Sahay BK. Role of yoga in diabetes. J Assoc Physicians India 2007;55:121-6.
4. Dham S, Shah V, Hirsch S, Banerji MA. The role of complementary and alternative medicine in diabetes. Curr Diab Rep 2006;6:251-8.
5. Shembekar AG, Kate SK. Yoga exercises in the management of diabetes mellitus. J Diabetic Assoc India 1980;20:167-71.
6. Innes KE, Vincent HK. The influence of yoga-based programs on risk profiles in adults with type 2 diabetes mellitus: A systematic review. Evid Based Complement Alternat Med 2007;4:469-86.
7. Raghuraj P, Telles S. Effect of yoga-based and forced uninostril breathing on the autonomic nervous system. Percept Mot Skills 2003;96:79-80.
8. Khanam AA, Sachdeva U, Guleria R, Deepak KK. Study of pulmonary and autonomic functions of asthma patients after yoga training. Indian J Physiol Pharmacol 1996;40:318-24.
9. Mourya M, Mahajan AS, Singh NP, Jain AK. Effect of slow- and fast-breathing exercises on autonomic functions in patients with essential hypertension. J Altern Complement Med 2009;15: 711-7.
10. Udupa K, Madanmohan, Bhavanani AB, Vijayalakshmi P, Krishnamurthy N. Effect of pranayam training on cardiac function in normal young volunteers. Indian J Physiol Pharmacol 2003;47:27-33.
11. Taneja I, Deepak KK, Poojary G, Acharya IN, Pandey RM, Sharma MP. Yogic versus conventional treatment in diarrhea-predominant irritable bowel syndrome: A randomized control study. Appl Psychophysiol Biofeedback 2004;29:19-33.
12. Sathyaprabha TN, Satishchandra P, Pradhan C, Sinha S, Kaveri B, Thennarasu K, *et al*. Modulation of cardiac autonomic balance with adjuvant yoga therapy in patients with refractory epilepsy. Epilepsy Behav 2008;12:245-52.
13. Cheema BS, Marshall PW, Chang D, Colagiuri B, Machliss B. Effect of an office worksite-based yoga program on heart rate variability: A randomized controlled trial. BMC Public Health 2011;11:578.
14. Chaya MS, Ramakrishnan G, Shastry S, Kishore RP, Nagendra H, Nagarathna R, *et al*. Insulin sensitivity and cardiac autonomic function in young male practitioners of yoga. Natl Med J India 2008;21:217-21.
15. Jyotsna VP, Joshi A, Ambekar S, Kumar N, Dhawan A, Sreenivas V. Comprehensive yogic breathing program improves quality of life in patients with diabetes. Indian J Endocrinol Metab 2012;16:423-8.
16. Stevens DL. The use of complementary and alternative therapies in diabetes. Clin Fam Prac 2002;4:911-28.
17. Brown RP, Gerbarg PL. Sudarshan Kriya Yogic breathing in the treatment of stress, anxiety, and depression. Part II: Clinical applications and guidelines. J Altern Complement Med 2005;11:711-7.
18. Brown RP, Gerbarg PL. Sudarshan Kriya yogic breathing in the treatment of stress, anxiety, and depression: Part I-neurophysiologic model. J Altern Complement Med 2005;11:189-201.
19. Hohnloser SH, Klingenheben. Basic auitonomic tests. In: Marek M, editor. Clinical Guide to Cardiac Autonomic Tests. Netherland: Kluwer Academic Publishers; 1998. p. 51-65.
20. Jyotsna VP, Sahoo A, Sreenivas V, Deepak KK. Prevalence and pattern of cardiac autonomic dysfunction in newly detected type 2 diabetes mellitus. Diabetes Res Clin Pract 2009;83:83-8.
21. Skoro-Kondza L, Tai SS, Gadelrab R, Drincevic D, Greenhalgh T. Community based yoga classes for type 2 diabetes: An exploratory randomised controlled trial. BMC Health Serv Res 2009;9:33.

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