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A PRELIMINARY REPORT ON THE ROLE OF YOGA ASANAS ON OXIDATIVE STRESS IN NON-INSULIN DEPENDENT DIABETES MELLITUS

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ABSTRACT

Nineteen subjects of non-insulin dependent diabetes mellitus (NIDDM) between the age group of 30 - 60 yrs were studied to see the effect of specific yoga asanas on fasting and postprandial blood glucose (FBG, PPG), serum malondialdehyde (MDA) and glycosylated hemoglobin (HbA_1) in addition to drug treatment and diet control. The duration of diabetes ranged from 1 - 10 years. Patients with renal, cardiac and proliferative retinal diseases were excluded from the study. The same patients served as their own control. Subjects were called in the morning to the cardio-respiratory laboratory and were given training by a yoga expert. Yoga asanas included Suryanamskar, Tadasan, TriKonasan, Padmasan, Pranayam, Paschimottanasan, Ardhmatsyendrasan, Pavanmukthasan, Sarpasan and Shavasan. The asanas were done every day for 40 days for 30 - 40 min. FBG, PPG, serum MDA and HbA_1 were estimated before and after 40 days of yoga asanas regimen. Significant reduction was seen in FBG from 220 mg / dl to 162 mg / dl, PPG from 311 mg / dl to 255 mg / dl, MDA from 6 nmol / l to 3 nmol / l and HbA_1 from 8.8 % to 6.4 %. Subjects felt better and were relieved of their stresses and had an improvement in their day to day performance. The decrease was statistically significant ($p < 0.0001$ for FBG and PPG, $p < 0.001$ for MDA and for HbA_1).

KEY WORDS : Blood glucose, malondialdehyde, hyperglycaemia, *yoga asanas*, non-insulin dependent diabetics (NIDDM).

INTRODUCTION

Oxidative stress is implicated in a number of diseases including diabetes mellitus. Enhanced oxidative stress along with decreased antioxidative status causes progression of the disease (1). Antioxidant defenses are located intra and extra cellularly. A diet rich in fruits, nuts, grains and vegetables rich in Vitamin E has antioxidant effect and seems to protect the stressful effect of glucose metabolism (1-3). However, as antioxidant defenses are not completely efficient, increased free radical formation in the body is likely to increase damage. Commonly produced free radicals like superoxide (O^-) and nitric oxide (NO^+) are not highly reactive but under certain circumstances generate toxic products that are harmful (1). The role of oxygen free radicals in causing damage and destruction may be irreversible/reversible and involves nucleic acids, proteins, amino acids, lipids, lipoproteins, carbohydrates and connective tissue macromolecules. Oxidative stress, the term used for deleterious free radical formation collectively, is present in a number of conditions like inflammations, induced by exercise, aging, cancer and in many other stressful disease (4- 8).

In non-insulin dependent diabetes mellitus (NIDDM) there is derangement of carbohydrate, lipid and protein metabolism due to insulin or its receptor deficiency (9). There are some reports on the beneficial effects of *yoga asanas* and / or meditation on fasting

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and postprandial blood glucose (FBG and PPG) (10,11). To our knowledge there are, however, no reports on the combined effect of yoga asanas, breathing exercises (Pranayama) and meditation on malondialdehyde (MDA) in diabetic patients. This aspect is studied and preliminary results are presented here.

MATERIALS AND METHODS

Nineteen men and women of NIDDM (mild to moderate diabetics) in the age group of 30 - 60 years were selected from the out patient clinic of G.T.B. hospital for the present study. All the patients were non smokers, middle class, literate and were on drugs (duration 1 - 10 years) and diet control. None of the patients had apparent cardiac, renal, hepatic, retinal or any other complication. After initial assessment and detailed information about yoga, written consent was taken from them. Every one received personalised attention and supervision of a yoga expert during yoga sessions, carried out in the cardio-respiratory laboratory in Physiology department in the morning time (30-40 min) every day for 40 days. Patients were kept on the same drug and diet control through out the study before and after yoga therapy. The basal parameters studied included biochemical investigations FBG, PPG, MDA and HbA_1 level besides having ECG, nerve conduction and pulmonary function tests. Blood sugar measurements were done by glucose oxidase method of Trinder (12), MDA by that of Satoh (13) and HbA_1 by ion exchange resin kit (Stangen immunodiagnostics). Table 1. shows the different asanas done (14) with their duration (11). Blood glucose (fasting and postprandial), MDA and HbA_1 were estimated before and after 40 days of yoga asanas. So the same patients served as their own control.

RESULTS

Table 2. shows the glycaemic control, as well as MDA and HbA_1 levels of 19 subjects. Fasting blood glucose was reduced from 210.7±76.9 mg/dl to

Table 1. Name and duration of various asanas included in yogic exercises.

S.No.	Name	Duration
1.	Surya Namaskar 1	3 – 7 turns of each, the pose being maintained for ten seconds adding one turn each, every fortnight
2.	Surya Namaskar 2	3 – 7 turns of each, the pose being maintained for ten seconds adding one turn each, every fortnight
3.	Tadasana	¼ minute to one minute, adding ¼ minute per week
4.	Trikonasana	¼ minute to one minute for each side , adding ¼ minute per week
5.	Sukhasana	¼ minute to one minute, adding ¼ minute per week
6.	Padmasana	¼ minute to one minute, adding ¼ minute per week
7.	Bhastrika Pranayama	5 – 15 minutes per day
8.	Paschimottanasana	¼ minute to one minute for each side , adding ¼ minute per week
9.	Ardhamatsyendrasana	¼ minute to one minute for each side , adding ¼ minute per week
10.	Vajrasana	¼ minute to one minute, adding ¼ minute per week
11.	Pawanmuktasana	¼ minute to one minute for each side , adding ¼ minute per week
12.	Naukasana	3 – 7 turns of each, the pose being maintained for ten seconds adding one turn each, every fortnight
13.	Bhujangasana	3 – 7 turns of each, the pose being maintained for ten seconds adding one turn each, every fortnight
14.	Dhanurasana	3 – 7 turns of each, the pose being maintained for ten seconds adding one turn each, every fortnight
15.	Shavasana	2 - 10 minutes, adding 2 minutes per week

These asanas are described in reference 14 and their duration in reference 11

Table 2. Fasting blood glucose (FBG), postprandial blood glucose (PPG), serum malondialdehyde (MDA) and glycosylated hemoglobin (HbA_1) values before and after 40 days of Yoga Asanas.

	N	Mean ± S.D./S.E.	Correlation	Sig.
* FBG1 (mg/dl)	19	210.7 ± 76.9/17.6	0.40	0.000
FBG2 (mg/dl)	19	140.4 ± 42.8/9.81		
* PPG1 (mg/dl)	19	305.5 ± 10.9/25.4	0.82	0.000
PPG2 (mg/dl)	19	230.5 ± 120.6/27.7		
* MDA1 (mmol/ml)	19	5.9 ± 3.8/ 0.86	0.44	0.001
MDA2 (mmol/ml)	19	2.9 ± 2.3/ 0.52		
* $HbA_1$1 (%)	19	8.8 ± 1.7	0.001	
$HbA_1$2 (%)	19	6.4 ± 1.8		

** 1 indicates the values before and 2 after yoga asanas*

140.4±42.8 mg/dl, postprandial blood glucose (PPG) from 305.5±110.9 mg/dl to 230.5±120.6 mg/dl ($p < 0.0001$ for FPG and PPG), MDA from 5.9±3.8 mmol/l to 2.9±2.3 mmol/l and HbA_1 from 8.8±1.7 % to 6.4±1.8 % level ($p < 0.001$ for MDA and HbA_1), thereby indicating decreased level of blood glucose as well as lipid peroxidation/ oxidative stress.

DISCUSSION

In diabetes mellitus because of prolonged hyperglycaemia there is increased oxidative stress resulting in, an increased free radical production and insufficient antioxidant defense status due to improper utilisation of glycogen by the tissues (15-18). The high oxidative stress is reflected by higher MDA level of 5-8 mmol/ml in diabetic patients when compared with normal value of 2-4 mmol/ml. Higher MDA levels are seen in a number of diseases and not just in diabetes (NIDDM) only, which is due to deficiency of insulin and defect in insulin receptors. Higher MDA level shows abnormal lipid peroxidation which adds to the complications of diabetes (19-22).

Physical exercise improves blood sugar, but paradoxically increases oxidative stress. However, a controlled relaxation stretch exercise produced significant reduction of glucose, glycosylated hemoglobin and lipid profile. According to Sahay (11), Yoga Mudra and Salabhasan are harmful to diabetic patients because they increase blood glucose level instead of decreasing. So we excluded these two from the yoga asanas recommended to diabetic patients in the present study. There are reports to show that practice of yoga and meditation reduce the plasma level of lipid peroxidation and is associated with decreased oxidative stress (23-25). The level of MDA reduction is shown in psychosomatic diseases. In the present study, the level of MDA was measured to show the level of stress in diabetes (NIDDM). The relaxation stretch exercises resulted in a stable autonomic balance, relative hypometabolic state and improvement in physical and mental efficiencies (26,27).

Yoga asanas in combination with conventional medical treatment provides a better metabolic control giving a feeling of general well being, alertness and attentiveness without any side effects. Yoga practice improves the status of NIDDM probably by more than one way (28). In the present study, fasting and postprandial blood glucose, glycosylated hemoglobin and MDA also came down, which is statistically significant at $p < 0.001$ level. Various yoga asanas may be directly rejuvenating / regenerating cells of pancreas as a result of which there may be increase in utilisation and metabolism of glucose in the peripheral tissues, liver and adipose tissues through enzymatic process (28). Combined beneficial effects could be utilised by performing asanas, meditation along with conventional antidiabetic regimen. However, a detailed study of the levels of insulin and enzymes as well as pancreatic functions is necessary to know about the underlying mechanism.

In conclusion, these studies show that combination of yoga asanas, breathing exercises and meditation not only shows better glycemic control but also reduces oxidative stress and improves day to day performance, which is in agreement with the findings of earlier workers.

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REFERENCES

1. Halliwell, B. (1994) Free radicals, antioxidants and human disease: curiosity, cause or consequence. Lancet 344, 721-723.
2. Jain, S.K. (1999) Should high- dose vitamin E supplementation be recommended to diabetic patients? Diabetes Care. 22 (8), 1242-1244.
3. Jain, S.K. (1996) The effect of modest vitamin E supplementation on lipid peroxidation products and other cardiovascular risk factors in diabetic patients. Lipids, Suppl. S87-90.
4. Scarpetini, F., Sbracia, M. and Scarpellini, L. (1994) Psychological stress in lipid peroxidation in miscarriage. Ann. N.Y Acad. Sci. 709, 210-213.
5. Santos, T.M., Valles, J. and Aznar, J. (1988) Plasma lipid peroxides in patients with vascular disease and in middle aged normal subjects with high risk of atherosclerosis. In : CRC Handbook of free radicals and antioxidants in biomedicine. Lockwell Wood, U.K. Vol. 1, p. 232-254.
6. Javad, J.N., Sarmadi, T., Mc Carthy, S., Bellerridge, D.J. and Wolff, S.P. (1995) Elevated levels of authentic plasma hydroperoxides in NIDDM. Diabetes 44, 1054-1058.
7. Maxwell, R.J. (1995) Prospects for the use of antioxidants therapies. Drugs 47, 902-906.
8. Alessio, H.M. (1993). Exercise induced oxidative stress. Med. Sci. Sports Exercise. 25 (2), 218-222.
9. Seman, C.K.H. and Slater, T.F. (1993) Free Radicals in Medicine. Brit. Med. Bull. 4 (3), 424-729.
10. Jain, S.C., Uppal, A, Bhatnagar, S.O.D. and Talukdar, B. (1993) A study of responses pattern of non-insulin dependent diabetics to yoga therapy. Diabetes Res. Clin. Practice. 19, 69-74.
11. Dang, K.K. (1999) Yoga and meditation for Health. In : Medicine Update. Ed. M.M. Singh Proc. conf. The Association of Physicians of India, New Delhi, Vol. 9, Part 1, Chap. 57, p. 502-506. Sahay, B.K. (1999) yoga meditation idem. chap. 58, p. 507-513.
12. Trinder, P. (1969) Determination of glucose in blood using glucose oxidase with an alternative oxygen receptor. Ann. Clin. Biochem. 6, 24.
13. Satoh, K. (1979). Serum lipid peroxide in cerebrovascular disorders determined by a new colorometric method. Clinical Chem. Acta. 90, 37-40.
14. Swamy Vyas Dev Ji (1970) First Steps to Higher Yoga. Translated by Bala-Brahmachari Ram Pyari Shastri. Yoga Niketan Trust, Gangotri, (Rishikesh) India, The Raisana Printery, p. 59-281
15. Sen, C.K. and Hanninen, O. (1994) Physiological antioxidants. In: Exercise and oxygen toxicity Eds. Sen, C.K., Palker, L. and Hanninen, O. Elsevier Science, Amsterdam. p. 89-216.
16. Holley, A.E. and Cheeseman, K.H. (1993) Measuring free radical reactions in *vivo*. Brit. Med. Bull. 49, 494-505.

17. Metz, S.A. (1983) Altered arachodonic acid synthesis and lipid peroxidation in diabetes mellitus: Possible roles in leukocyte dysfunction and other cellular defects. Med. Hypothesis. 12, 341-357.

18. Collier, A. and Rumley A.G. (1992) Free radical activity and haemostatic factors in NIDDM patients with or without microalbuminuria. Diabetes. 4, 909-913.

19. Babiy, A.V., Gebicki, J.M., Sullivan, D.R. and Willey, K. (1992) Increased oxidisability of plasma lipoproteins in diabetic patients can be decreased by probucol therapy and is not due to glycation. Biochem. Pharmacol. 43, 995-1000.

20. Wolff, S.P. (1987) The potential role of oxidative stress in diabetes and its complications, Novel implications for theory and therapy. In: Diabetic Complications: Scientific and Clinical aspects Ed. Crabble, M.J.C. Churchill Livingstone, Edinburg, U.K. p. 167-200.

21. Cross, C.E., Halliwall, B., Borish, E.T., Pryor, W.A., Ames, B.B., Saul, R.L., Mc Cord, J.M. and Harman, D (1987) Oxygen radicals and human disease. Ann. Intern. Med. 107, 526-545.

22. Nishigaki, I., Hagihara, M., Tsunekaw, H., Maseki, M. and Yagi, K. (1981) Lipid peroxides level of serum lipoprotein fractions of diabetic patients. Biochem. Med. 25, 373-378.

23. Jain, S.C. and Talukdar, B. (1995) Role of yoga in control of hyperglycaemia in middle aged patients of non-insulin dependent diabetes mellitus. Ind. J. Clin. Biochem. 10 (2), 62-65.

24. Schneider, R.H., Nidich, S.I., Salerno, J.W., Sharma, H.M., Robinson, L.E., Nidich, R.J. and Alexander, C.N. (1998) Lower Lipid peroxide level in practitioners of Transcendental programme. Psychosomatic Medicine. 60, 38-41.

25. Jain, S.K., Kreuger, K.S., McVie, R., Jaramillo, J.J., Palmer, and M., Smith, T. (1998) Relationship of blood thromboxane- B2 (TxB2) with lipid peroxides and effect of vitamin E and placebo supplementation on TxB2 and lipid peroxide levels in type 1 diabetic patients. Diabetes Care. 21 (9), 1511-1516.

26. Sahay, B.K., and Murthy, K.J.R. (1988) Long term follow up studies on effect of yoga in diabetes. Diab. Res. Clin. Pract. 5 (suppl. 1), S655.

27. Sahay, B.K. (1994) Yoga and Diabetes. In: Proceedings of Noro Nordisk diabetes update. Ed. Anil Kapur Health Care Communication, Bombay, India. p. 159-167.

28. Rugmini, P.S. and Sinha, R.N. (1976) The effect of Yoga therapy in Diabetes Mellitus. Seminar on Yoga, Man and Science, Yoga Research Hospital, Vishwayatan Yogashram, New Delhi, India. p. 175–189.