Indian J Physiol Pharmacol 2002; 46 (3) : 313–320

STUDY OF YOGA ASANAS IN ASSESSMENT OF PULMONARY FUNCTION IN NIDDM PATIENTS

VARUN MALHOTRA*, SAVITA SINGH*, K. P. SINGH#, P. GUPTA*, S. B. SHARMA**, S. V. MADHU# AND O. P. TANDON*

Departments of Physiology, Medicine# and Biochemistry**,*
University College of Medical Sciences & GTB Hospital,
Shahdara, New Delhi – 110 095

(Received on September 25, 2001)

Abstract : Certain *yoga asanas* if practiced regularly are known to have beneficial effects on human body. These yoga practices might be interacting with various, somato-neuro-endocrine mechanisms to have therapeutic effects. The present study done in twenty four NIDDM patients of 30 to 60 year old, provides metabolic and clinical evidence of improvement in glycaemic control and pulmonary functions. These middle-aged subjects were type II diabetics on antihyperglycaemic and dietary regimen. Their baseline fasting and postprandial blood glucose and glycosylated Hb were monitored along with pulmonary function studies. The expert gave these patients training in yoga *asanas* and were pursed 30–40 min/day for 40 days under guidance. These *asanas* consisted of 13 well known postures, done in a sequence. After 40 days of *yoga asanas* regimen, the parameters were repeated. The results indicate that there was significant decrease in fasting blood glucose levels (basal 190.08 ± 90.8 in mg/dl to 141.5 ± 79.8 in mg/dl). The postprandial blood glucose levels also decreased (276.54 ± 101.0 in mg/dl to 201.75 ± 104.1 in mg/dl), glycosylated hemoglobin showed a decrease (9.03 ± 1.4% to 7.83 ± 2.6%). The FEV1, FVC, PEFR, MVV increased significantly (1.81 ± 0.4 lt to 2.08 ± 0.4 lt, 2.20 ± 0.6 lt to 2.37 ± 0.5 lt, 3.30 ± 1.0 lt/s to 4.43 ± 1.4 lt/s and 64.59 ± 25.7 lt min to 76.28 ± 28.1 lt/min respectively). FEV1/FVC % improved (85 ± 0.2% to 89 ± 0.1%). These findings suggest that better glycaemic control and pulmonary functions can be obtained in NIDDM cases with *yoga asanas* and *pranayama*. The exact mechanism as to how these postures and controlled breathing, interact with somato-neuro-endocrine mechanism affecting metabolic and pulmonary functions remains to be worked out.

Key words : *Yoga asanas* *pranayama* glycosylated hemoglobin Type 2 diabetes blood glucose Pulmonary Function

INTRODUCTION

Various metabolic and clinical disorders are associated with diabetes mellitus. The most prominent being vascular disease. It is generally agreed that hyperglycemic patients have a higher incidence of pulmonary infections may lead to develop

*Corresponding Author

tuberculosis, emphysema, asthma, fibrosis and mucormycosis during course of disease (1, 2, 3, 4, 5, 6). All these respiratory disorders cause altered pulmonary function tests (7). Amongst others peripheral airflow obstruction increase significantly with age in diabetics as compared to healthy subjects which is obvious against environmental challenges e.g. smoking or minor airway infection. Deterioration of the pulmonary function is proportional to the degree of hyperglycemia (8, 9).

Deterioration of pulmonary function has been reported amongst Insulin and Non-insulin Dependent diabetes (9, 10) who were on conventional therapy. This shows that strict regimes of dietary control & physical exercises along with oral hypoglycemics has a limited role in helping the diabetic patients to improve the functioning of their lungs. The importance of finding alternative avenues of treatment to ensure improvement of patient's health cannot be over emphasised.

Yoga has been applied to the field of therapeutics in recent times. *Yoga asanas* are static comfortable postures and *pranayama* is rhythmic controlled breathing. The previous studies involving pranayamic breathing has shown to relax and improve pulmonary function in normal subjects (11). However, there are very few studies of pulmonary function amongst diabetics (7, 9), especially amongst NIDDM patients (10) as most of the studies have been done on insulin dependent diabetics (8). Besides, the lung studies amongst NIDDM patients, particularly in association with yoga are virtually non-existent. This study was undertaken to understand the effect of *yoga asanas* on pulmonary function in NIDDM patients.

METHOD

I. Selection of subjects

- Patients of Type 2 Diabetes Mellitus (NIDDM) with history of Diabetes of 1–10 years in the age group of 30–60 years were selected.
- Subjects with nephropathy, retinopathy (proliferative and coronary artery disease were excluded from the study.
- Subjects were on recommended diet and oral hypoglycemic drugs.

II. Grouping

- *Yoga* group comprised subjects who did yoga asanas as shown in Table I under the supervision and guidance of a Yoga expert for a period of 40 days.
- The patients served as their own control their own control.

PARAMETERS

All subjects were assessed for the following parameters before starting Yogic training and after 40 days of *Yoga asanas*.

- Biochemical
- Pulmonary

Table I : Name and duration of various asanas included in yoga.

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 for adding ¼ minute per week
4.	*Trikona-asana*	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.	*Ardhmatsyendrasana*	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

Biochemical parameters

- **Fasting and Postprandial Blood Glucose levels** were estimated in plasma by Glucose Oxidase method of Trinder (12).
- **Glycosylated Hemoglobin (GHb)** was measured by fast Ion-Exchange Resin Separation method using Human GmbH kit.
- **Pulmonary Parameter.** Pulmonary function parameters were measured using Spiro 232, PK Morgan with an on line computer as below:

FEV1 (lt) Forced Expiratory Volume in First Second, FVC (lt) Forced Vital Capacity, FEV1/FVC (Ratio), PEFR (lt/sec) Peak Expiratory Flow Rate, MVV (lt/min) Maximal Voluntary Ventilation.

Table I shows the different asanas and pranayama done with their time duration (13).

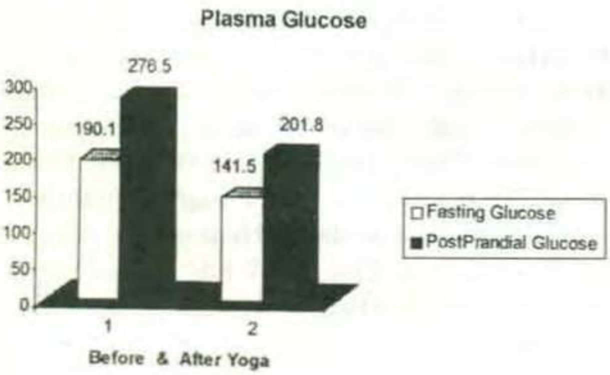
RESULTS

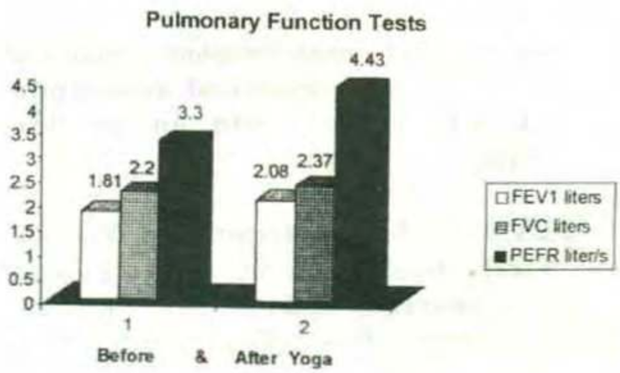
Table II shows glycaemic control, glycosylated hemoglobin ad pulmonary function values before and after 40 days of yoga asanas. Fasting blood glucose (FBG) reduced from 190.1 mg/dl to 141.5 mg/dl ($P<0.001$), Postprandial Blood Glucose (PPG) from 276.5 mg/dl to 201.7 mg/dl ($P<0.001$) and plasma Glycosylated Hemoglobin (HbA_1) values from 9.03% to 7.83% ($P<0.035$), thereby indicating a better glycaemic control.

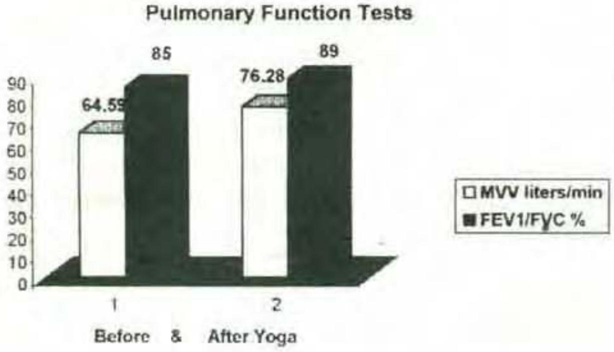
Table II: Fasting blood glucose (FBG), postprandial blood glucose (PPG), pulmonary function, and glycosylated hemoglobin (GHB) values before and after 40 days of *Yoga asanas*.

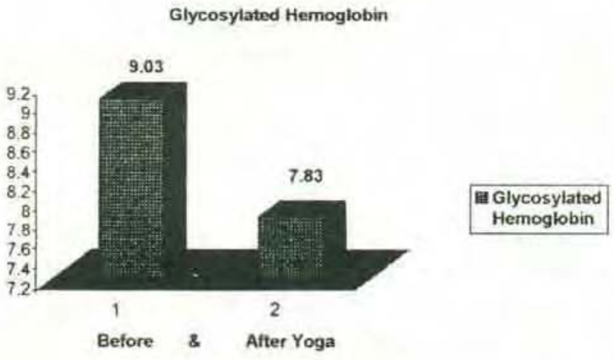
	N	*Mean ± S.D./S.E.*	*Correlation*	*Sig.*
*FBG	24	190.1±/90.8/18.54 141.5±/79.8/16.3	0.79	0.001*
*PPG	24	276.5±/101/20.62 201.8±/104.1/21.24	0.74	0.001*
*FEV	24	1.81±/0.4/0.07 2.08±/0.4/0.08	0.54	0.001*
*FVC	24	2.20±/0.6/0.12 2.37±/0.5/0.10	0.80	0.026*
*FEV_1/FVC	24	0.85±/0.2/0.04 0.89±/0.1/0.02	0.20	0.362[NS]
*PEFR	24	3.30±/1.0/0.21 4.43±/1.4/0.29	0.40	0.001*
*MVV	24	64.59±/25.7/5.25 76.28±/28.1/5.73	0.60	0.027*
*GHB	19	9.03±/1.4/0.29 7.83±/2.6/0.53	0.26	0.035*

*	Significant at P value of <0.05
NS	Not-Significant
FBG (mg/dl)	Fasting Blood Glucose
PPG (mg/dl)	Post Prandial Blood Glucose
FEV_1 (lt)	Forced Expiratory Volume in First Second
FVC (lt)	Forced Vital Capacity
FEV_1/FVC (%)	Forced Expiratory Volume in First Second/Forced Vital Capacity
PEFR (lt/s)	Peak Expiratory Flow Rate
MVV (lt/min)	Maximal Voluntary Ventilation
GHB (%)	Glycosylated Hemoglobin









Forced Expiratory Volume in First Second (FEV_1) increased from 1.81 lt to 2.08 lt (P<0.001), Forced Vital Capacity (FVC) form 2.20 lt to 2.37 lt (P<0.026) and FEV1/FVC from 85% to 89% (at P<0.362), Peak expiratory flow rate (PEER) from 3.30 to 4.43 lt/sec (P<0.001) and Maximal Voluntary Ventilation (MVV) from 64.59 to 76.28 lt/sec (P<0.027), thereby showing an improved pulmonary function.

DISCUSSION

Diabetes Mellitus is a slowly progressive disease that deteriorates the normal functioning of lung (14) as can also be observed from the findings shown in Table II. Limited joint mobility that occurs as a consequence of changes in structural proteins of the joints of the chest and elastin and collagen abnormalities of the pulmonary capillaries and smooth muscles of airways may be the reason for reduced total lung capacity and the disordered lung mechanics (15). A reduction of inspiratory capacity is due to reduced capacity of the muscles (16, 17, 18). However, a consistent reduction in MVV among diabetics was seen only in subjects with severe obesity (Weight/height greater than 1.1 kg/cm) (19, 20).

Pranayama appears to be a specialised respiratory exercise capable of inducing series of beneficial effects besides causing significant improvement of respiratory functions. Yogic asanas have been observed to lower rate of respiration, increase FEV1/FVC, increase slow vital capacity, maximal voluntary ventilation, peak respiratory flow rate (PEFR), expansion of chest, vital capacity, ability to hold breath and reduce bronchial hyperactivity (21, 22, 23, 24).

In our study a measurable degree of airflow obstruction was relieved with *yoga asanas and pranyama* as can be seen with a statistically significant improvement of PEFR and an improvement of FEV1/FVC. The exact mechanism involved is not known however, nostril breathing (25) releases epinephrine in patients with diabetic autonomic neuropathy, reducing parasympathetic bronchomotor tone, resulting in increased basal airway caliber (26).

Improvement of the FEV_1, FVC and MVV shows a measurable increase in the respiratory pump efficiency. In different *asanas*, the abdominal wall is brought into activity. This in turn works on the diaphragm and moves it better, thus helping the lungs empty efficiently. Proper relaxation during various asanas helps to remove the tension in the respiratory muscles and this in turn can also help the patients to exhale more easily.

The minimum production of carbon dioxide in the body through *yoga asanas* results in slowing the activity of the lungs and the heart (27). Besides, as the individual is relaxed in pranayamic breathing, the basic need of oxygen decreases. There occurs neither oxygen debt nor increased levels of lactic acid as is otherwise associated during heavy exercises. CO_2 levels in the blood can very easily increase in pranayamic breathing but it will always remain below the maximum allowable level (28). The gradual rise in CO_2 levels also has psychophysiological effects on the individual as compared to a sudden rise or fall of CO_2 levels that may occur during exercise.

Besides, voluntary control by conscious effort on thoracic muscles and abdominal muscles alters the blood gas concentration. Breathing our forcefully decreases the pCO2, which acts on the chemoreceptor area of the brain to modify activity of the generator neurons of respiration in the respiratory center (26). Modification of the higher centers may result in overall improvement of pulmonary function.

Besides, with pranayamic breathing the patients felt good Yoga relaxes, relieves stress, makes the patient feel good, alert, active and exhilarated by releasing opioids and altering adrenocortical activity that gives pleasurable sensations and keeps the body fit (29).

Conclusion

Yoga studies have aroused a hope for the diabetics to reduce medication (30), which has been confirmed in our study by improving the glycaemic control. *Pranayamic* breathing makes the diabetic patients feel good (31).

Controlled breathing improves lung function when practiced regularly in mild to moderate diabetics. However, more studies are required with respect to the exact mechanism involved. Studies are also required with respect to helping patients with different diseases through *pranayama*.

ACKNOWLEDGEMENTS

We are grateful to SitaRam Sahu, Technical Assistant and my colleagues Dr. Rajesh among others for helping us by assisting us in doing pulmonary function tests. Shri JL Goswami and his personnel for giving technical help in estimation of biochemical parameters. Dr. Indrayan and his team for his help in statistical work and the cooperation of the subjects without whose help this research would not be completed. Their help in thankfully acknowledged.

REFERENCES

1. Abramowitz S, Leiner GL, Small MJ. Chronic respiratory diseases and diabetes. *Rev Allergy* 1961; 23: 972.
2. Holden Hm, Hiltz JE. The tuberculous diabetic. *Can Med Assoc J* 1962; 87: 797.
3. Textbook of Pulmonary Disease. 3rd Edition. Edited by Gerald L. Baum, Emanuel Wolinsky 1983: 1167–68.
4. Textbook of Pulmonary Disease. 5th Edition. Edited by Gerald L. Baum, Emanuel wolinsky 1994: 1149–1150.
5. Goto Y, Sato S and Masuda. Causes of death in 2151 diabetic autopsy cases. *Tohoku J Exp Med* 1974; 112: 339–353.
6. Tunbridge WMG. Factors contributing to deaths of diabetic, less than fifty year to age. *Lancet* 1972; 11: 569–572.
7. Cooper BG, Taylor R, Albeit KGM and Gibson GH. Lung functions in-patients with diabetes mellitus. *Rspir Med* 1990; 84: 235–239.
8. Ramirez LC, Nogare DA, Hsia C, Araur C, Butt I, Strowig MS, Breen SL. Relationship between diabetes control and pulmonary function in insulin dependent diabetes mellitus. *Am J Med* 1991; 91: 371.
9. Lange P, Groth S, Kastrup J, Appleyard M, Nyboe J, Jensen G, Schnohr P. Diabetes mellitus, plasma glucose and lung function in a crossectional population study. *Eur Respir J* 1989; 2: 14–19.
10. Singh S, Singh KP, Girlal S, Sircar SS. Are ventilatory impairments related to early onset and long history of diabetes *JIMA* 1993; 458–468.
11. Udupa KN, Singh RH, Settiwar: RM. A comparative study on the effect of some individual Yogic practices in normal person. *Indian J Med Res* 1975; 63: 1066–1071.
12. Trinder P. Determination of glucose in blood using glucose oxidase with an alternative oxygen receptor. *Ann Clin Biochem* 1996; 6: 24.
13. Swamy Vyas Dev Ji. First Steps to Higher Yoga. Translated by Bala-Brahmachari Dr. Ram Pyari Shastri Yoga Niketan Trust, Gangotri, Uttar-Kashi, Rishikesh (Uttarakhand). *The Raisana Printery*. 1970; 59–281.
14. Malhotra V, Singh S, Tandon OP, Gupta P, Sharma SB, Madhu SV. Status Of NIDDM patients after Yoga Asanas: Assessment of Some Important Parameters. Thesis (unpublished). University College of Medical Sciences, University of Delhi; April 2001.
15. Schuyler MR, Niewoehner RI, Inkley SR, Kohn R. Abnormal lung elasticity in juvenile diabetes mellitus. *Am Rev Respir Dis* 1976; 113: 3741.
16. Wanke T, Formanek D, Auinger M, Popp W, Zwick H, Irsigler K. Inspiratory muscle performance and pulmonary function changes in IDDM. *Am Rev Respir Dis* 1991; 143–197.
17. Cooper BG, Taylor R, Alberti KGMM, Gibson GJ: Lung function in patients with Diabetes Mellitus. *Resp Med* 1990; 84: 235–239.
18. Primhak RA, Whincup G, Tsanakas JN, Milner RDG: Reduced vital capacity in insulin dependent Diabetes Mellisu. *Diabetes* 1987; 36: 324–326.
19. Kollias J, Boileau RA, Ballett HI, Buskink ER. Pulmonary function and physical conditioning in lean and obese subjects. *Arch Environ Health* 1972; 25: 146–150.
20. Ray CS, Sue DM, Bray G, Hansen JE, Wasserman K. Effects of obesity on respiratory function. *Am Rev Respir* 1983; 128: 501–508.
21. Murthy KJR, Sahay BK, Madhavi S, Sitaramaraju P, Yogi R, Venkat Reddy M, Annapurna N, Ramesh M, Vijaylakshmi P, Eshwar Reddy EM: Effect of Yoga on ventilatory functions in normal healthy volunteers. *Lung India* 1983; 1: 189–192.
22. Murthy KJR, Sahay BK, Sitaramaraju P, Madhavi S, Yogi R, Reddy MV, Annapurna N, Ramesh M, Vijaylakshmi P, Eshwar Reddy EM: Effect of Pranayama (Rechaka, Puraka, Kumbaka) on bronchial asthma-an open study. *Lung India* 1984; 2: 87–191.
23. Kumar A, Kumari GK, Kumari GD, Sahay BK, Murthy KJR: Immediate effects of Pranayama in airway obstruction. *Lung India* 1985; 3: 77–81.
24. Nagarathna R, Nagendra HR. Yoga for bronchial astham-controlled study. *British Medical Journal* 1985; 291: 977–1079.

25. Telles S, Nagarathna R, Nagendra HR. Breathing through a Particular Nostril can alter Metabolism and Autonomic Activities. *Indian J Physiol Pharmacol* 1994; 38(2): 133–137.

26. Conceicao Santos-e-Fonseca MC, Manco Josec, Gallo Lourenco Jr, Bareira Amilton A, Foss Milton C. Cholinergic Bronchomotor tone and airway caliber in IDDM. *Chest* 1992; 101: 1038.

27. MV Bhole. A Comparative Study of Minute Ventilation in Deep and Pranayamic Breathing. *Yoga Mimamsa* July 1977; October 1978; Vol. 19: 8–20.

28. Wallace RK, Benson H, Wilson AF. A wakeful hypometabolic physiologic state. *Am J Physiol* 1971; 221: 795–799.

29. Raju PS, Anil Kumar K, Reddy SS, Madhavi S, Gnanakumari K, Bhaskaracharyulu C, Sahay BK, Murthy KJR: Effect of *Yoga* on exercise tolerance in normal healthy volunteers. *Ind J Physiol Pharmac* April-June 1986; 121–132.

30. Rugmini, PS, Sinha RN. The effect of *Yoga* therapy in Diabetes Mellitus. Seminar on *Yoga*, Man and Science, Delhi India 1976; p.175–189. *Yoga Research Hospital Vishwayatan Yogashram, CCRIMH, New Delhi.*

31. Singh Savita, Malhotra Varun, Singh KP, Sharma SB, Madhu SV, Tandon OP. A preliminary report on the role of *yoga asanas* on oxidative stress in non-insulin dependent diabetes. *Ind J of Cl Biochem* 2001; 16(2): 216–220.