Indian J Physiol Pharmacol 2002; 46 (3) : 298–306

EFFECT OF YOGA ASANAS ON NERVE CONDUCTION IN TYPE 2 DIABETES

VARUN MALHOTRA, SAVITA SINGH, O. P. TANDON†, S. V. MADHU*, ATUL PRASAD** AND S. B. SHARMA***

Departments of Physiology, Medicine, Neurology** and Biochemistry***, University College of Medical Sciences & Guru Tegh Bahadur Hospital and Institute of Human Behaviour & Allied Sciences Delhi – 110 095*

(Received on September 24, 2001)

Abstract : Twenty Type 2 diabetic subjects between the age group of 30–60 years were studied to see the effect of 40 days of *Yoga asanas* on the nerve conduction velocity. The duration of diabetes ranged from 0–10 years. Subject suffering from cardiac, renal and proliferative retinal complications were excluded from the study *Yoga asanas* included *Suryanamskar. Tadasan, Konasan, Padmasan Pranayam, Paschimottansan Ardhmatsyendrasan, Shavasan, Pavanmukthasan, Sarpasan* and *Shavasan*. Subjects were called to the cardio-respiratory laboratory in the morning time and were given training by the *Yoga* expert. The *Yoga* exercises were performed for 30–40 minutes every day for 40 days in the above sequence. The subjects were prescribed certain medicines and diet. The basal blood glucose, nerve conduction velocity of the median nerve was measured and repeated after 40 days of *Yogic* regime. Another group of 20 Type 2 diabetes subjects of comparable age and severity, called the control group, were kept on prescribed medication and light physical exercises like walking. Their basal & post 40 days parameters were recorded for comparison. Right hand and left hand median nerve conduction velocity increased from 52.81 ± 1.1 m/sec to 53.87 ± 1.1 m/sec and 52.46 ± 1.0 to 54.75 ± 1/1 m/sec respectively. Control group nerve function parameters deteriorated over the period of study, indicating that diabetes is a slowly progressive disease involving the nerves. *Yoga asanas* have a beneficial effect on glycaemic control and improve nerve function in mild to moderate Type 2 diabetes with sub-clinical neuropathy.

Key words : *Yoga asanas* type 2 diabetes nerve conduction

INTRODUCTION

Diabetic neuropathies comprise diffuse, symmetrical, predominantly sensory neuropathy often associated with autonomic dysfunction, acute mononeuropathies, affecting single nerves such as the femoral or oculomotor and pressure palsies, particularly of the median and ulnar nerves (1). Distal symmetrical neuropathy of a clinical significant degree probably affects 20–30% of the diabetic subjects (2). Its

†Corresponding Author

prevalence rises with increasing duration, severity of diabetes (3, 4, 5) and other include predominance in male gender, age (irrespective of the duration of diabetes), smoking, associations increasing height and microalbuminuria (5, 6).

Hyperglycemia reduces myoinositol but increases glucose influx through polyol pathway and reduces Na^+-K^+-ATPase activity. Increased Na^+, K^+, sorbitol and fructose concentrations in the nerve absorb water through osmosis. Accumulated water causes the compression of the nerves, which leads to decreased axonal transport (7). Pathological features of diabetic peripheral neuropathy include distal axonal loss with fall out of large (myelinated) and small fibers, focal demyelination and regeneration (8, 9). Functional abnormalities include slowing of conduction velocity and rise in sensory modality thresholds. Downie et al have reported a mild decrease in conduction velocity in all nerves and fibers but is more prominent in distal segments in a group of patients with diabetes mellitus, with clinical signs or symptoms of peripheral neuropathy. In a sub-group of these patients, there is a greater decrease in the median nerve at the wrist and ulnar nerve at the elbow, sites of chronic compression (10). Friedrich et al have seen an incidence of slowing in conduction of motor nerves of the upper extremities as frequently as along those of the lower extremities (11).

A reduced conduction velocity may be either due to selective injury to the fastest fibers or a retarded conduction velocity in all fibers owing to a metabolic abnormality. Mulder et al have also reported fiber loss in the nerves in diabetes as is evident from the low amplitude of evoked muscle action potential (12). A reduced conduction velocity reflects sub-clinical affection of motor nerve fiber in diabetics (13). The motor conduction velocity in the nerves of the upper limb and the sensory conduction velocity in the lower limb are affected to the same extent due to the same size of the fibres (14).

It has been established that *Yogic* exercises reduce blood sugar (15), serum lipid peroxide thereby decreasing toxicity of oxygen free radicals (16), lower oxidative stress, gradually shift of the autonomic equilibrium towards a relative parasympathetic dominance and release endorphins & enkephalins. It was, therefore, endeavoured to scientifically study the role and effect of *Yogic* exercises on Type 2 diabetes mellitus patients by measuring parameters like blood glucose and electrophysiological parameters using modern techniques.

METHODS

The study of assessment of electrophysiological parameters before and after 40 days of *Yogic* exercise by Type 2 diabetes patients was conducted in Departments of Physiology, Biochemistry and Medicine, University College of Medical Sciences and Guru Tegh Bahadur Hospital, Delhi and Department of Neurology, Institute of Human Behaviour of Allied Sciences, Delhi.

Selection of subjects : Forty Type 2 diabetes patients with history of diabetes of 0–10 years in the age group of 30–60 years were selected. Diagnosis of Type 2 diabetes patients were done according to WHO criteria Technical Report Series: The diagnostic details are given in the review of literature.

Screening and methodology

- Subjects with nephropathy, retinopathy (proliferative) and coronary artery disease were excluded from the study.
- Subjects were divided in to two separate groups.
- **Group I**, the *Yoga* group, patients were put through various *Yogic asanas* for 40 days together with recommended diet plus traditional diabetic medicines ($n_1 = 20$). They acted as their own controls.
- **Group II**, the control group, patients were retained on recommended diet plus normal walking exercise etc. plus normal medical therapy only ($n_2 = 20$). Controls were matched in respect of age, sex, socio-economic status and glycaemic base line parameters.
- Routine laboratory tests were done before and after *Yoga asanas.*
- Relevant parameters were recorded at the beginning (i.e. baseline values) and after 40 days of *Yoga asanas* for n_1 group. Similar parameters were recorded for n_2 group in the beginning and after 40 days.
- The recorded parameters were compared, statistically analysed and conclusion drawn therefrom.
- All *Yogic asanas* were conducted under the guidance and supervision of a *Yogic* expert. A qualified doctor was also present during the exercises so as to attend to the patients, as and when required.

Parameters : All subjects were assessed for the following parameters before starting *Yogic* training and after 40 days of *Yoga asanas.* The control group subjects were also assessed for the same parameters before and after a period of 40 days.

- **Electrophysiological parameters.** Motor median nerve conduction velocity and other parameters were measured by disc type, surface electrodes using Medlec Saphire Evoked Potential Recorded. The procedure is as follows :
  - A red coloured recording electrode is placed on the skin over *Abductor Pollicis Brevis.*
  - A black coloured reference electrode is placed on the skin over proximal phalynx of thumb.
  - A wet stimulating electrode is placed at the level of palmar aspect of mid wrist medial to *palmaris longus* tendon, with cathode proximal to anode.
  - A wet ground electrode is tied around the wrist between the stimulating and recording electrodes.
  - The median nerve is stimulated at the level of wrist by a potential difference

prevalence rises with increasing duration, severity of diabetes (3, 4, 5) and other include predominance in male gender, age (irrespective of the duration of diabetes), smoking, associations increasing height and microalbuminuria (5, 6).

Hyperglycemia reduces myoinositol but increases glucose influx through polyol pathway and reduces Na^+-K^+-ATPase activity. Increased Na^+, K^+, sorbitol and fructose concentrations in the nerve absorb water through osmosis. Accumulated water causes the compression of the nerves, which leads to decreased axonal transport (7). Pathological features of diabetic peripheral neuropathy include distal axonal loss with fall out of large (myelinated) and small fibers, focal demyelination and regeneration (8, 9). Functional abnormalities include slowing of conduction velocity and rise in sensory modality thresholds. Downie et al have reported a mild decrease in conduction velocity in all nerves and fibers but is more prominent in distal segments in a group of patients with diabetes mellitus, with clinical signs or symptoms of peripheral neuropathy. In a sub-group of these patients, there is a greater decrease in the median nerve at the wrist and ulnar nerve at the elbow, sites of chronic compression (10). Friedrich et al have seen an incidence of slowing in conduction of motor nerves of the upper extremities as frequently as along those of the lower extremities (11).

A reduced conduction velocity may be either due to selective injury to the fastest fibers or a retarded conduction velocity in all fibers owing to a metabolic abnormality. Mulder et al have also reported fiber loss in the nerves in diabetes as is evident from the low amplitude of evoked muscle action potential (12). A reduced conduction velocity reflects sub-clinical affection of motor nerve fiber in diabetics (13). The motor conduction velocity in the nerves of the upper limb and the sensory conduction velocity in the lower limb are affected to the same extent due to the same size of the fibres (14).

It has been established that *Yogic* exercises reduce blood sugar (15), serum lipid peroxide thereby decreasing toxicity of oxygen free radicals (16), lower oxidative stress, gradually shift of the autonomic equilibrium towards a relative parasympathetic dominance and release endorphins & enkephalins. It was, therefore, endeavoured to scientifically study the role and effect of *Yogic* exercises on Type 2 diabetes mellitus patients by measuring parameters like blood glucose and electrophysiological parameters using modern techniques.

METHODS

The study of assessment of electrophysiological parameters before and after 40 days of *Yogic* exercise by Type 2 diabetes patients was conducted in Departments of Physiology, Biochemistry and Medicine, University College of Medical Sciences and Guru Tegh Bahadur Hospital, Delhi and Department of Neurology, Institute of Human Behaviour of Allied Sciences, Delhi.

Selection of subjects : Forty Type 2 diabetes patients with history of diabetes of 0–10 years in the age group of 30–60 years were selected. Diagnosis of Type 2 diabetes patients were done according to WHO criteria Technical Report Series: The diagnostic details are given in the review of literature.

Screening and methodology

- Subjects with nephropathy, retinopathy (proliferative) and coronary artery disease were excluded from the study.
- Subjects were divided in to two separate groups.
- **Group I**, the *Yoga* group, patients were put through various *Yogic asanas* for 40 days together with recommended diet plus traditional diabetic medicines ($n_1 = 20$). They acted as their own controls.
- **Group II**, the control group, patients were retained on recommended diet plus normal walking exercise etc. plus normal medical therapy only ($n_2 = 20$). Controls were matched in respect of age, sex, socio-economic status and glycaemic base line parameters.
- Routine laboratory tests were done before and after *Yoga asanas*.
- Relevant parameters were recorded at the beginning (i.e. baseline values) and after 40 days of *Yoga asanas* for n_1 group. Similar parameters were recorded for n_2 group in the beginning and after 40 days.
- The recorded parameters were compared, statistically analysed and conclusion drawn therefrom.
- All *Yogic asanas* were conducted under the guidance and supervision of a *Yogic* expert. A qualified doctor was also present during the exercises so as to attend to the patients, as and when required.

Parameters : All subjects were assessed for the following parameters before starting *Yogic* training and after 40 days of *Yoga asanas*. The control group subjects were also assessed for the same parameters before and after a period of 40 days.

- **Electrophysiological parameters.** Motor median nerve conduction velocity and other parameters were measured by disc type, surface electrodes using Medlec Saphire Evoked Potential Recorded. The procedure is as follows :
  - A red coloured recording electrode is placed on the skin over *Abductor Pollicis Brevis*.
  - A black coloured reference electrode is placed on the skin over proximal phalynx of thumb.
  - A wet stimulating electrode is placed at the level of palmar aspect of mid wrist medial to *palmaris longus* tendon, with cathode proximal to anode.
  - A wet ground electrode is tied around the wrist between the stimulating and recording electrodes.
  - The median nerve is stimulated at the level of wrist by a potential difference

25% greater than the threshold voltage, above which no increase in amplitude of the evoked muscle action potential (EMAP) is seen. This reproducible test reading is recorded.

- The wet stimulating electrode is then placed at the level of elbow just medial to palpable brachial artery and the median nerve is stimulated again by a supra-threshold stimulus. The reproducible test reading is recorded.
- The similar steps of procedure are followed for the other hand.
- The distance between the wrist and elbow electrodes of both hands is recorded. In all eight readings (four before and four after forty days) are taken.
- The velocity is calculated by dividing the distance by time delay taken by the electrical impulse (latency) to reach the pick up electrodes, for both hands separately.

Asanas for Type 2 Diabetes Patients: According to Sahay et al 1999, 13 specific *Yoga asanas* (17) viz. *Surya Namaskar, Trikonasana, tadasana, Sukhasana, Padmasana, Bhastrika Pranayama, Pashimottanasana, Ardhmatsyendrasana, Pawanmuktasana, Bhujangasana, Vajrasana, Dhanurasana* and *Shavasana* are beneficial for diabetes mellitus. In this study, 20 Type 2 diabetic patients followed these *Yoga asanas.* The subjects of the n_1 group strictly followed all the recommended precautions and the practiced *Yoga asanas* under the expert guidance of a *Yoga* instructor.

RESULTS

Yoga Group: The observations and results of 20 Type 2 diabetic subjects in *Yoga* group (n_1) were recorded and are enumerated in the succeeding paragraph. Table I shows Mean ± S.E. values of nerve conduction parameters of 20 diabetes subjects. The details are as follows.

- The conduction velocity had increased in both right and left hand from 52.81 ± 1.1 m/sec to 53.87 ± 1.1 m/sec and 52.46 ± 1.0 m/sec to 54.75 ± 1.1 m/sec respectively but the change was more prominent in left hand and was statistically significant. The details of left hand conduction velocity are shown in Fig. 1.
- The proximal latency had decreased in the right hand from 7.48 ± 0.4 m/sec to 7.30 ± 0.3 milli sec due to stretching but practically had no change in the left hand 7.81 ± 0.2 milli sec.
- The distal latency had decreased in the left hand from 4.34 ± 0.3 milli sec to 4.27 ± 0.3 milli sec but increased in the right hand from 4.02 ± 0.1 milli sec to 4.26 ± 0.3 milli sec.
- The proximal and distal amplitude had decreased in the right hand from 6.65 ± 0.5 mV to 6.22 ± 0.4 mV and 6.73 ± 0.5 mV to 6.55 ± 0.5 mV respectively.

Table I : Nerve conduction velocity before and after 40 days of *Yoga asanas* in group I subjects.

Parameters n = 20	*Before Yoga Mean ± S.E.*				*After Yoga Mean ± S.E.*			
	Right		*Left*		*Right*		*Left*	
	Proximal	*Distal*	*Proximal*	*Distal*	*Proximal*	*Distal*	*Proximal*	*Distal*
Amplitude (mV)	6.65±0.5	6.73±0.5	6.90±0.4	7.02±0.4	6.55±0.5	6.22±0.4	6.66±0.4	7.78±0.6
Latency (msec)	7.48±0.4	4.34±0.3	7.81±0.2	4.34±0.3	7.30±0.3	4.27±0.3	7.81±0.2	4.27±0.3
Velocity (m/sec)	52.81±1.1		52.46±1.0		53.87±1.1		54.75±1.1*	

•Significant at P value ≤0.05
Proximal – Elbow and Distal-Wrist

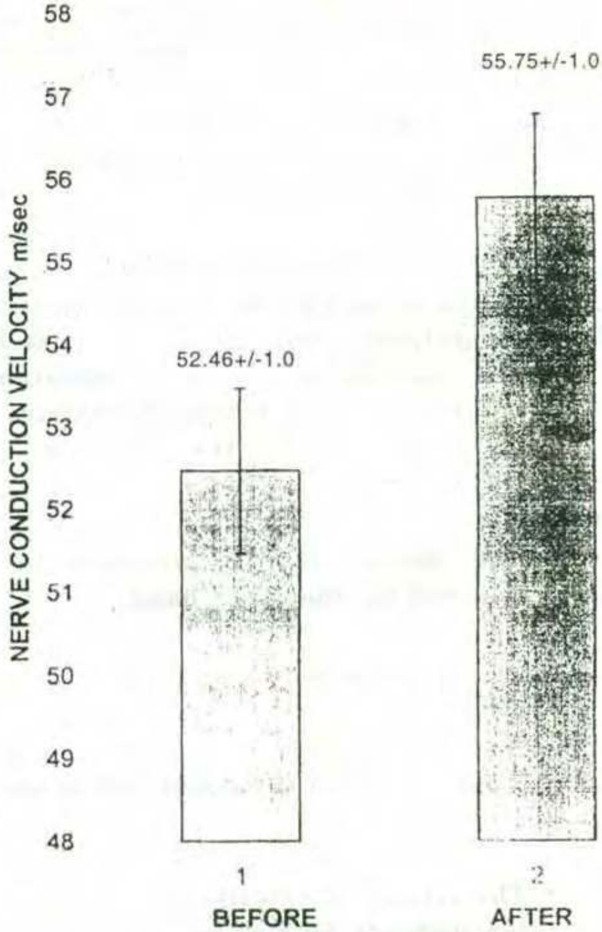

Fig. 1 : Left hand nerve conduction velocity before & after 40 days of Yoga graph 5.6 (P<0.033)

- The proximal amplitude had decreased in the left hand from 6.90 ± 0.4 mV to 6.66 ± 0.4 mV.
- The distal amplitude had increased in the left hand from 7.02 ± 0.4 mV to 7.78 ± 0.6 mV.

Control Group : The observations are results of 20 diabetes subjects in the control group (n_2) wre recorded and are enumerated in the succeeding paragraph Table II shows

Table II : Nerve conduction velocity before and after 40 days of *routine exercise* in group 2 subjects.

Parameters n = 20	*Baseline Mean ± S.E.*				*After 40 days Mean ± S.E.*			
	Right		*Left*		*Right*		*Left*	
	Proximal	*Distal*	*Proximal*	*Distal*	*Proximal*	*Distal*	*Proximal*	*Distal*
Amplitude (mV)	6.81±0.5	7.23±0.5	6.30±0.4	7.06±0.5	5.92±0.5*	6.71±0.6	5.84±0.4	6.19±0.5
Latency (msec)	7.84±0.3	4.09±0.1	7.67±0.2	3.74±0.1	7.84±0.2	4.12±0.1	7.59±0.2	4.02±0.1
Velocity (m/sec)	53.75±1.0		54.53±1.0		54.03±0.8		54.31±1.3	

*Significant at P value ≤0.05
Proximal – Elbow and Distal-Wrist

Mean ± SE of the nerve conduction parameters along with their level of statistical significance in 20 Type diabetes subjects. The details are as follows :

- The conduction velocity had increased in the right hand 53.75 ± 1.0 m/sec to 54.03 ± 0.8 m/sec but had decreased in the left hand from 54.53 ± 1.0 m/sec to 53.31 ± 1.3 m/sec.
- The proximal latency had practically no change in the right hand from 7.84 ± 0.3 milli sec to 7.84 ± 0.2 milli sec.
- The proximal latency had decreased in the left hand from 7.66 ± 0.2 milli sec to 7.59 ± 0.2 milli sec.
- The distal latency had increased in both the right and left hand from 4.09 ± 0.1 milli sec to 4.12 ± 0.1 milli sec and 3.74 ± 0.1 milli sec to 4.02 ± 0.2 milli sec respectively.
- The proximal and distal amplitude had decreased in the right hand from 6.81 ± 0.5 mV to 5.92 ± 0.5 mV and 7.23 ± 0.5 mV to 6.71 ± 0.6 mV respectively. Reduction in proximal amplitude in the right hand is statistically significant.
- The proximal and distal amplitude had decreased in the left hand from 6.30 ± 0.3 mV to 5.84 ± 0.4 mV and 7.06 ± 0.6 mV to 6.19 ± 0.5 mV.

Levene's Test for Equality of Variances : The analysis of the recorded results by Levene's test showed that there was equality of variances in both groups. In that, in both groups, there were significant decrease in LV at P value of 0.036. The analysis is statistically significant.

DISCUSSION

The control group of diabetics comprised subjects of comparable age and severity who did other physical exercises and who were on diet regime & drug therapy with mild physical exercise i.e. walking in place of *Yoga asanas*. The changes in the various parameters were recorded. The patients suffered a progressive loss of function of the nerves, which was confirmed by analysing their nerve conduction velocity of the median nerve. There occurred a slowing of the conduction velocity along with a decrease in the distal amplitude. Type 2 diabetes patients on therapy still have sub-clinical involvement of peripheral nerves. This shows that diabetes is a progressive disease affecting not only the myelin sheaths but also the axons.

Very few studies are available on the effect of *Yoga asanas* on different parameters in Type 2 diabetes patients. In fact, only Sahay et al (1999) have conducted the studies and have shown the beneficial effects of *Yoga asanas* in Type 2 diabetes cases (17). The present study was conducted in mild to moderate cases of Type 2 diabetics. It is observed that there was a significant fall in the fasting and post prandial blood glucose. The present study has shown the effect of few specific *Yoga asanas* on the nerve conduction velocity in diabetes.

In diabetes mellitus because of prolonged hyperglycemia, there occurs sub-clinical neuritis, which slowly leads to neuropathy due to insufficient oxygen utilisation and compression of the nerves due to water retention. Thus there occurs a decrease in conduction velocity, distal amplitude and an increase in distal latency. The delayed latency and decrease in amplitude of evoked response in the nerve without clinical symptoms, suggests sub-clinical involvement of the nerves.

The increase in non-dominant hand conduction velocity was significantly higher than the right hand after *Yoga asanas*. The distal amplitude of non-dominant hand in the diabetic subjects who were on *Yoga asanas* also increased. The vibration sense as measured by a tuning fork was better appreciated and the motor reflexes also improved. The latency decreased but was at variance in the two hands. These changes were mainly due to significant decrease in blood sugar, as conduction velocity has a proportional co-relation to blood sugar control (3). The other reasons were proper utilisation of oxygen by the nerves as measured by decrease in oxidative stress. The variance in results in both hands may be explained as follows :

- The increase in non-dominant hand velocity was significant because the nerve of this side was weak initially, as most patients were right handed. Sub maximal stretch exercises make the nerves strong, flexible and the body stable. This is in support of Lamarckian theory of 'Use and Disuse atrophy' that states, the development and efficiency of organs/muscles are in proportion to the use of these organs/muscles, disuse leads to final weakening of that particular organ/muscle (18).

- The increase in velocity recorded in right hand was found to be less than the left hand. It may be due to continued use of the right hand in day to day activities, through which the muscles are modified continuously in its form and were enlarged to begin with. However, the number of subjects was small, besides the time duration of *Yoga asanas* was less only for 40 days for conclusive evidence but the change is visible through the results. It is stated that if the duration of asanas were increased beyond 40 days and the blood sugar brought under control a significant increase in conduction velocity in both hands would be better appreciated.

Since distal amplitude, latency and nerve conduction are the major parameters affected by blood sugar, improvement in glycaemic control may lead to reversal of subclinical neuropathy as measured by these parameters. Other parameters such as proximal latency and amplitude showed an insignificant change because of intra observed variations such as placement of electrodes, besides being affected by various other factors other than blood sugar. Studies regarding the effect of *Yoga* on the nerve conduction velocity in Type 2 diabetics are virtually nonexistent. This study is one of the firsts of its kind. It has been established that *Yogic* exercises reduce blood sugar (11) and serum lipid peroxide thereby decreasing toxicity of oxygen free radicals (19). It is, therefore, suggested that the practice of *Yoga asanas* can decrease nerve injury and control or improve diabetic neuropathy.

The subjects felt better, were relieved of their stresses, had improvement in their day to day performance and developed a sense of well being *Yoga asanas* relax, relieve stress and 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 (20). Anand et al (21) reported dominance of alpha rhythm in the EEG activity of the persons trained in *Yoga* (21).

The findings conform to the general view in the medical fraternity that diabetes mellitus is a slowly progressive disease effecting most systems in the body and perpetually deteriorates their normal functioning. However, specific *Yoga asanas* along with prescribed meditation and diet help arrest the progress of further complications of the disease and perhaps slow down it.

ACKNOWLEDGEMENTS

We are grateful to Mr. Yashpal, Technical Assistant for helping us in doing the nerve conduction studies, Shri J.L. Goswami and his personnel for 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 work would have not been completed. Their help is thankfully acknowledged.

REFERENCES

1. Pickup JC, Williams G. Text book of Diabetes. Volume 2, 1997 (Second Edition).
2. Newrick PG, Boulton AJM, Ward JD. The distribution of diabetic neuropathy in a British Clime population. *Diabetes Res Clin Pract* 1986; 2: 263–268.
3. Porte D, Graf RJ, Halter JB, Pfeifer MA, Halar E. Diabetic neuropathy and plasma glucose control. *Am J Med* 1981; 70: 195–200.
4. Thomas PK. Diabetes neuropathy: models, mechanism and mayhem. *Can J Neurol Sci* 1992; 19: 1–7.
5. DCCT Research Group. Factors in development of diabetic neuropathy. Baseline analysis of neuropathy in feasibility phase of Diabetes Control and Complications Trial (DCCT). *Diabetologia* 1988; 37: 476–483.
6. Pirart J. Diabetic mellitus and its degenerative complications: A prospective study of 4000 patients observed. *Diabetes Care* 1978; 1: 168–88, 252–263.
7. Greene DA, Lattimer SA, Seemer AAF. Sorbitol, phosphoinositides and sodium-potassium ATPase in pathogenesis of diabetic complications. *N Engl Med* 1987; 316: 599–606.
8. Chopra JS, Hurwitz LJ. A comparative study of peripheral conduction in diabetes and non-diabetic occlusive peripheral vascular disease. *Brain* 1969; 92: 83–96.
9. Fagerberg SE. Study on the pathogenesis of diabetic neuropathy. *Acta Med Scan* 1957; 157: 401–419.
10. Downie AW and Newell DJ. Sensory nerve conduction in-patients with diabetes mellitus and controls. *Neurology (Minneap.)* 1961; 11: 876.
11. Fredrich Behse, Fritz Buchthal and Frits Carlsen. Nerve biopsy and conduction studies in diabetes neuropathy. *Psychiatry* 1977; 40" 1072–1082.
12. Mulder DW. Lambert EH, Sprague RG. The neuropathies associated with diabetes mellitus. *Neurology (Minneap.)* 1961; 11: 275–284.
13. Woltman HW, Wilder RH. Diabetes mellitus: Pathologic changes in the spinal cord and peripheral nerves. *Arch Intern Med* 1929; 44: 576–603.
14. Lawrence DG, Locke S. Motor nerve conduction velocity in diabetes. *Arch Neur* 1961; 5: 37–43.
15. Sahay BK, Murthy KJR, Raju PS, Madhavi S, Prasad, Reddy MV: Role of Yogic practices in prevention of NIDDM in Abstracts of 15th International Diabetes Federation Congress. Kobe; 1994: 95.
16. Schneider RH, Nidich SI, Salerno JW, Sharma HM, Robinson CE. Nidich RJ, Alexander CN. Lower lipid peroxide level in practitioners of transcendental meditation program. *Psychosomatic Medicine* 1998; 60: 38–41.
17. Dang KK, Sahay BK. (1999) Yoga and meditation, Medicine Update. Chapters 57 and 58. Volume 9, Part 1. The Association of Physicians of India Ed. M.M. Singh. APICON, New Delhi, 502–506, 507–512.
18. Jean Baptiste Pierre Antoinede Monet/Chevalier de Lamarck (1744–1829) 'Philosophic Zoologique' Jordan-Nigam. *Animal Biology* 1992–93. 25th Edition: 922–923.
19. Singh S, Malhotra V, Singh KP, Sharma SB, Madhu SV, Tandon OP. A Preliminary Role of *Yoga asanas* on oxidative stress n NIDDM. *Ind J of Cl Biochem* 2001; 16(2): 216–220.
20. Udupa KN, Singh RH, Settiwar RM. A comparative study on the effect of some individual *yogic* practices in normal persons. *Indian J Med Res* 1975; 63: 1066–1071.
21. Anand BK. Some aspects of electroencephalographic studies on yogis. *Electroencephalog Clin Neurophysiol* 1961; 13: 452–456.