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Original Article

Effect of glycemic control on nerve conduction studies

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ABSTRACT

Purpose: - To assess the glycosylated hemoglobin in experimental and control group, to compare the sensory nerve conduction between experimental and control group and to correlate the motor nerve conduction between experimental and control group. Methods: - An experimental design was adopted. Twenty diabetic patients and twenty health individuals were selected by random sampling technique. BMI, FBS, PPBS and HBA1C estimated for all subjects and nerve conduction studies were carried out on Neuro perfect EMG-200 system. Results: - The data were analyzed by using descriptive and inferential statistics. The findings revealed that in experimental group FBS, PPBS, HbA1C is higher, sensory nerve conduction decreased and is significant with control group and motor conduction is in normal range and is not significant. Conclusion: - With proper glycemic control the motor nerve changes and complications of sensory disturbances can be prevented.

1. Introduction

It is well known that Diabetes Mellitus is a common disorder all over the world. It is a clinical syndrome characterized by hyperglycemia due to absolute (or) relative deficiency of insulin. Lack of insulin effects the metabolism of carbohydrate, protein, fat and cause a significant disturbance of water and electrolyte homeostasis. There are two types of diabetes. Type-1 Diabetes also called insulin dependent diabetes mellitus (IDDM) is due to lack of insulin secretion. Type-II Diabetes is also called non-insulin dependent diabetes mellitus (NIDDM) is caused by decreased sensitivity of target tissues to the metabolic effect of insulin. This reduced sensitivity to insulin is often called insulin resistance. In both types of diabetes mellitus, metabolism of all the main food stuffs is altered1.

Insulin deficiency increases blood sugar level by (a) diminished glucose entry in to cells and decreased peripheral utilization and (b) increased gluconeogenesis. As the blood glucose level exceeds the renal threshold 180 mg/dl and rate of glucose filtration exceeds the glucose Tm (320 mg/mt), glucose appears in urine.

Unabsorbed glucose in the proximal tube reduced water reabsorption causing an osmotic diuresis and polyurea resulting in dehydration and loss of electrolytes. This stimulates thirst and causes polydypsia. Decreased intracellular glucose, and diminished glucose entry in to the ventromedial nucleus of hypothalamus inhibits the satiety centre and increases appetite and food intake that is polyphagia. But diminished utilization of glucose leads to mobilization of endogenous proteins and fats stores and leads to weight loss. In diabetus there is excess extra cellular glucose but deficient intracellular glucose[2].

Diabetic Neuropathy: The common and early complication is Neuropathy and is present even at the time of diagnosis. Although in a few patients it can cause severe disability, it is symptomless. Though there is evidence that the central nervous system is affected in long term diabetes, the clinical impact of diabetes is mainly manifest on the peripheral nervous system. The diabetic neuropathies are heterogenous and may be focal or diffuse3.

The most common pattern of neuropathy in diabetes is a distal symmetric polyneuropathy in which sensory symptoms and

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2. Material and Method

deficits predominant and are initially confined to distal lower limb sites, weakness is minimal (or) absent until much later and, like sensory loss, effects the distal lower limbs initially4.

Peripheral nerve conduction studies: The velocity at which an impulse is conducted along a motor (or) sensory nerve can be measured with great accuracy. Nerve conduction velocity is an expression of the physiological and pathological state of the nerve. There are three kinds of nerve conduction studies :- 1) The motor nerve conduction test. 2) Sensory nerve conduction test. 3) The mixed nerve conduction test.

1. Motor nerve conduction velocity For accurate motor nerve conduction velocity measurement, the distance between two points of stimulation should be atleast 10 cm. This reduces the error due to faulty distance measurement.

2. Sensory nerve conduction velocity (mt/sec) Sensory nerve conduction velocity may be measured by stimulating at a single stimulation site because the residual latency which comprises of neuromuscular transmission time and muscle propagation time is not applicable[4].

Assessment of Glycaemic Control :

Assessment by urine test has limitations in the diagnosis of both type-I and type-II diabetes patients where a raised renal threshold for glucose may mask persistent hyperglycaemia. Negative urine tests fail to distinguish between normal and blood glucose level while avoiding hyperglycaemia.

Normal Values: - Fasting plasma glucose > 7 mmol/L (70-110 mg/dl of blood).

- Random plasma glucose < 11 mmol/L (80-160 mg/dl of blood).

Glocosylated haemoglobin comprise HbA1. HbA1 is made up of HbA1a, HbA1b, HbA1C. HbA1C is the major fraction, constituting approximately 80% HbA1. Formation of GHb is essential irreversible, and the concentration in blood depends on both the life span of the red blood cell (average 120 days) and the blood glucose concentration. Because the rate of formation of GHb is diretly proportional to the concentration of glucose in the blood, the GHb concentration represents the integrated values for glucose over the preceding 6 to 8 weeks. This provides an additional criteria for assessing glucose control because GHb values are free of day to day glucose fluctuations and are by recent exercise or food ingestion. Normal HbA1C concentrates about 5 gm% of the total haemoglobin. In diabetic patients HbA1C is elevated to as high as 15 gm%.

The Concentration of HbA1C serves as an indication of blood glucose concentration over a period, approximating to the half life of RBC (haemoglobin) i.e., 6-8 weeks. A close correlation between the blood glucose and HBA1C concentrations have been observed when simultaneously monitored for several months. Normally, HbA1C concentration is about 3-5% of the total haemoglobin. In diabetic patients, HbA1C is elevated (to as high as 15%). Determination of HbA1C reflects the mean blood glucose level over 2 month's period to its measurement[5]

AIMS and Objectives:

1. To assess the glycosylated haemoglobin in experimental and control group.

2. To compare the sensory nerve conduction between experimental and control group.

3. To compare the motor nerve conduction between experimental and control group.

2. Materials and Methods

The methodology is presented under the following heading.

Research design: An experimental approach was adopted to this study.

Setting: The study was conducted in out patient departments and wards of neurology and endocrinology department of SVIMS University, Tirupati.

Population: The patients of diabetes mellitus type-Ii associated with peripheral neuropathy.

Experimental group: consists of diabetic patients (diabetes mellitus type-II) who were also having peripheral neuropathy symptoms. They were 20 in number aged between 38-69 years. All the patients are no oral hypoglyaemic agents. None were using insulin.

Control group: 20 Healthy individuals aged between 35-69 years. Subjects were screened for diabetes mellitus (By doing blood glucose tests) and hypertension by clinical examination and found negative.

Sampling technique: Random sampling technique.

Inclusive criteria: a) Having diabetes Mellitus type-II. b) On oral hypoglycaemic agents. c) Having peripheral neuropathic symptoms.

Exclusive criteria: Patients with alcohol in take, neurological disease, chronicrenal failure, chronic liver disease, chronic air way disease, carcinoma infections neurotoxic drugs and critical illness.

Instrument:

Equipment and specifications: The nerve conduction studies were carried out on NEURO PERFECT EMG-200. EMG/NCV/EP System (Medicaid Systems, Chandigarh) for all the 40 subjects.

Pilot study: The pilot study was done with the sample size of 4 patients (2 controls and 2 diabetic type-II patients) from wards of endocrinology and neurology departments of SVIMS University, Tirupati from 1-8-2008 to 15-8-2008. Content validity was done by the experts and a standardized instrument (Neuro perfect EMG-2000. EMG/NCV/EP system) was used to test the nerve conduction.

Data collection procedure : After taking the consent of the subjects detailed clinical examination was done to all subjects BMI measured. FBS, PPBS and glycosylated heamoglobin levels were estimated.

The following nerves were tested on both sides for the motor nerve conduction. 1. Median nerve, 2. Ulnar nerve, 3. Common peroneal nerve (CPN), 4. Posterior tibial nerve (PTN).

The following nerves were tested on both sides for the sensory nerve conduction (antidromic sensory nerve conduction study). 1. Median nerve, Ulnar nerve, 3. Sural nerve.

Data Analysis and Statistical Methods: - The statistical analysis was done based on SPSS package. Descriptive statistics such as mean and standard deviation and inferential statistics such as paired't' test was used to analyze the difference between experimental group and control group.

3. Results

Table 1: Estimation Of Bmi, Blood Sugar Level, & Hba1c Betwene Experimental & Control Group.

Variable	Experimental Group		Control Group		t. Value	P.Value
	Mean	SD	Mean	SD		
BMI (Sq cm)	26.03	4.08	22.78	1.85	3.24	0.002 S
FBS mg/dl	169.45	76.04	89.50	8.27	4.67	<0.001 S
PPBS mg/dl	235.25	87.28	106.50	8.10	6.58	<0.001 S
HbA1cg%	7.74	1.63	4.53	0.51	8.40	< 0.001 S

Table-1. Reveals of BMI, FBS & PPPS mean values are higher in subjects and these changes are significant statistically. Mean values of glycosylated haemoglobin levels are high in subjects and the values are statistically significant.

Table-2: Sensory Nerve Conduction In Experimental And Control Group

Types of Nerves	Experimental Group		Control Group		t. Value	P.Value
	Mean	SD	Mean	SD		
Median nerve						
Lat m/s	2.17	0.82	2.60	0.20	2.27	0.028 S
Amp (μv)	7.97	5.71	21.65	2.42	9.84	<0.001 S
NCV m/s	42.68	16.27	52.35	3.49	2.58	0.013 S
Ulnar nerve						
Lat m/s	2.61	0.90	2.46	0.23	0.72	0.47 NS
Amp (μv)	11.65	8.60	16.20	1.46	2.33	0.02 S
NCV m/s	41.18	22.15	54.56	2.99	2.67	0.01 S
Sural nerve						
Lat m/s	2.16	1.16	3.05	0.27	3.34	0.001 S
Amp ((μv)	8.30	7.92	7.44	1.23	0.47	0.63 NS
NCV m/s	36.77	19.62	46.75	3.36	2.24	0.03 S

Post tibial nerve	Experimental Group		Control Group		t. Value	P.Value
	Mean	SD	Mean	SD		
Lat m/s	2.29	4.49	4.76	0.43	2.44	0.02 S
Amp (μv)	4.10	6.38	4.95	0.46	0.59	0.55 NS
NCV m/s	25.57	24.30	41.12	1.69	2.85	0.007 S

Table-2 indicates; mean values of latency, amplitude and conduction velocity of Median nerve are decreased in subjects compared to controls. P value indicates significant change. Mean value of latency in ulnar nerve are within a narrow range in both groups and P value is not significant. The changes in amplitude and conduction velocity of ulnar nerve are significant with 'P' values. The changes in amplitude of both nerves are not significant. Latency and nerve conduction velocity of both sural and post tibia nerves are decreased and these changes are significant.

Table-3: Motor Nerve Conduction In Experimental And Control Group

Type of Nerve	Experimental Group		Control Group		t. Value	P.Value
	Mean	SD	Mean	SD		
COMMON						
PERONIAL NERVE						
Right side						
Lat m/s	4.02	0.53	4.03	0.63	0.05	0.95 NS
Amp (μv)	4.50	2.20	4.20	0.48	0.59	0.55 NS
NCV m/s	39.31	13.24	47.34	3.11	2.60	0.01 S
Left side			4.10	0.74		
Lat m/s	3.51	1.04	4.18	1.33	2.06	0.04 S
Amp (μv)	4.35	2.28	47.21	3.07	0.28	0.77 NS
NCV m/s	40.59	10.33			2.74	0.009 S
POST TIBIAL NERVE						
Right side						
Lat m/s	5.10	3.89	4.36	0.72	0.83	0.40 NS
Amp (μv)	6.98	3.56	5.01	1.13	2.36	0.02 S
NCV m/s	42.46	12.03	46.59	5.59	1.39	0.17 NS
Left side						
Lat m/s	4.63	3.45	4.40	0.77	0.29	0.77 NS
Amp (μv)	5.94	3.22	5.01	0.93	1.24	0.22 NS
NCV m/s	43.23	12.38	47.44	3.58	1.46	0.15 NS

Table-3 reveals, changes mean values of latency and amplitude on both sides are within narrow range and are not significant. Mean value of nerve conduction velocity are decreased on both sides. 'P' values indicate significance for common peroneal nerve.

Mean values of latency, amplitude and conduction velocity are within narrow range in both the groups. Mean values of amplitude of potential are increased in experimental group and on right side 'P' value is significant for post tibial nerve.

4. Discussion

In the developing countries like India, Type-II diabetes occurs at younger age (45-65 years). In our study, the range of age of study group is 38-68 years. Diabetic neuropathy is most common and troubles some complication leading to great morbidity with 12 time's higher risk of amputations.

Recent data from the WHO South-East Asia Region States that 32 million people in India are affected by diabetes and its complications. It is predicted that the number of cases are likely to be more than double by 2030. Due to life style of Urban areas, diabetes is more prevalent in urban populations. Unbalanced diet promotes obesity, and could possibly contribute to the diabetes epidemic in Asia. Rural Indians are migrating to Urban areas in search of better income and are beginning to follow an urban life style, which is accompanied by increasing obesity and insulin resistance6.

Body mass index (BMI) is derived from an objective formula for quantifying the degree of patient obesity. The National Diabetes Information clearing house, guidelines state that an individual with a BMI value of 25 to 29.9 Kg/m2 is considered over weight, and at 30 Kg/m2 or more a patient is categorized as being obese7.

The mean values of BMI of Experimental group was 26.03 and in control group was 22.78, "t" value was 3.24 and "P" value=0.002 which is statistically significant. Obesity greatly increases the risk of diabetes. An association of risk with increasing weight was evident even with in the non obese range.

The most studies used BMI as the measure of obesity. However, it has been postulated that fat mass, particularly visceral fat mass, is associated with insulin resistance and that indices of visceral fat such as waist hip ratio or waist circumference might be better predictor of risk of type-II diabetes. Individuals with diabetes in India are much thinner than their western counter parts7.

The common symptom of peripheral neuropathy in our study was tingling and numbness in 55% (11) burning feet, 35% (7) and 10% (2) has tingling + burning sensation + numbness + unsteadiness in walking. Other motor symptoms (co-ordination) are absent in all patients in the study. These figures are comparable with the work of Arindam Dutta et al8., whose figures suggestive of peripheral neuropathy were tingling 43.75 %, tingling and numbness 21.87%, tingling and burning feet 12.5%, burning feet alone 12.5% weakness of limb 6.25% and combination of tingling, numbness and burning feet in 3.13%.

All subjects of study group were on OHA (oral hypoglycemic agents) with diet control. Fasting and post prandial blood sugar levels were determined in both Experimental and control groups. In Experimental group the values were higher than the control group.

Fasting blood sugar values (in mg/dl) mean ± SD were 169.45 ± 76.04 (Experimental), 89.50± 8.27 (in controls) and T value = 4.67, "P" value 0.001, and post prandial blood sugar values mean ± SD were 235.25 ± 87.28 (Experimental), 106.50 ± 8.10 (in control) and T value 6.58 and "P" value < 0.001. glycosylated haemoglobin HbA1C values (in gms %) mean ± SD were 7.74 ± 1.63 (Experimental), 4.53 ± 0.51 (in control) and "t" value = 8.40 and "P" value = < 0.001. These are within normal limits and indicate glycemic control of diabetes with oral hypoglycemic drugs. This study supports the study of Vijay Viswanathan et al7, observed inverse correlation of sensory conduction velocity (SCV) and (motor nerve conduction velocity). MCV of peripheral nerves with HbA1C, fasting and post prandial glucose levels, indicating a possible direct cause and effect relation between hyperglycemia and abnormal SCV. In the present study, it is observed the same inverse relation between conduction velocity in sensory nerves median nerve, ulnar nerve, sural nerve and posterior tibial nerve.

Conduction velocity of compound muscle action potential of motor nerves of lower limbs common peronial nerve and post tibial nerve were / significantly decreased when compared with control group of other parameters, latency and amplitude are decreased in NIDDM compared to controls. But the change is not significant statistical.

The difference in sensory nerve conduction and motor nerve conduction may due to diameter and myelination of sensory and motor nerve. According to Erlanger and Gasser classification of motor nerve and large diameter nerves and groups under A$\propto$. Most of sensory nerves are Aβ and AδNeurons whose diameter are less compare to motor neuron. In Diabetes mellitus sensory nerves are affected first. So patients have symptoms of numbness, tingling and decreased sensation[9].

5. Conclusion

The present works indicate that the sensory nerves are affected earlier in diabetic neuropathy. With proper glycaemic control the motor nerve changes and complications of sensory disturbance can be prevented by regular screening for glycosylated hemoglobin levels in blood and nerve conduction studies.

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