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Effect of Neuromuscular Electrical Stimulation on Visual Evoked Potential in Type Ii Diabetic Patients

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ABSTRACT :
Aim:
The aim of the study is to examine feasibility and effectiveness of short term neuromuscular electrical stimulation (NMES) in median nerve of both the upper limb, to increases blood flow to limb and therefore the nerves themselves or for electrical current to be having a direct effect on the peripheral nervous system itself and can improve neuropathic symptoms, nerve function and conduction velocity of type 2 diabetic Mellitus Patients..
Methods:
This experimental study was conducted among the patients from both the sexes suffering from type 2 diabetic Mellitus for about 5 years after onset of disease (no.50) and 10 years after onset of disease (no.50) ,with an age and sex matched control group(no.50). The aim of the study was to assess the changes of different Electrophysiological parameters of Nervous system of type 2 Diabetes Mellitus patients after Neuro Muscular Electrical Stimulation. Out of the 50 patients in both patient groups 25 had underwent neuro muscular electrical stimulation, in which10 week long NEMS intervention were performed on both the upper limbs .The NMES training protocol consisted of 30 minutes session 5 days per week for 10 week. and we compare the effectiveness after assessing the post-operative results of electrophysiological parameters. The parameters we considered are, Latency N75, Latency P100 , Amplitude N75, Amplitude P100 of Visual Evoked potential of Right eye and left eye and the changes in blood glucose and cognitions related blood parameters were evaluated.
Result:
We have observed minor change in all parameters from pre-test to post test Latency P100, Amplitude N75, Amplitude P100 of Visual Evoked potential of Right eye of the type 2 Diabetes Mellitus patients within ten years after the onset of disease after NMES in the median Nerve. This observed difference was statistically significant ($p<0.05$).
CONCLUSION:
This observed difference was statistically significant and thus we conclude that NMES makes significant changes in VEP N75, P100, N145, N75-P100 of eye type 2 Diabetes Mellitus patients within ten years after the onset of disease after NMES in the median Nerve.

I. INTRODUCTION

Diabetic Mellitus is a world-wide epidemic associated with high morbidity and mortality. Diabetes affects almost all organs of the body therefore it might affect the nervous system also. In the initial stages peripheral nervous system may be affected, however the complication is progressive and may affect the higher enters in the brain too. They all seem to be related to blood sugar level too high for too long time.

Some people have nerve damage with symptoms other have no symptoms(1). Although diabetic neuropathy manifests clinically much later in course of the disease, yet its physiological evidence can be obtained much earlier with the help of electrophysiological tests(2). Electrophysiological investigations like sensory and motor nerve conduction studies are very sensitive method in determining peripheral and central neuropathy.

Nerve conduction studies shows whether the motor nerve transmit electrical impulses to the muscles or sensory nerves up to the brain at a normal speeds (conduction velocity) allow the brain to respond to pain ,touch, temperature and vibration.

The first step in management of T2DM patients with diabetic neuropathy should aim for stable glyceamic control, and maintain adequate blood flow. Exercise is fundamental in the prevention and treatment of type 2 Diabetes(3) .However many individuals face barrier to exercise . Neuromuscular electrical stimulation is an alternative conventional exercise, to that may prove beneficial in the treatment of T2D. Neuro Muscular Electrical Stimulation (NMES) is the application of mild and comfortable electrical stimulus to the Peripheral nerves using surface

electrodes on the motor points of nerves provoking the muscle contraction .Therefore the objective of this study was to investigate whether 10 weeks of training with our NMES stimulation can have a beneficial effect on nerve conduction parameters, heart rate, blood pressure, body composition of the individuals with T2D(4). Justification to the utilization of NMES is, the sedentary T2DM patients who face barrier to do exercise, NMES is an alternate method of exercise increasing blood flow to the limb and the electric current to the nerve themselves having direct effect on the electrophysiology of nervous system The NMES has been utilized in the treatment of neurological and other muscular disorders including diabetic neuropathy(5). Advantages of this treatment is, it is non invasive ,non pharmacological, non toxic, non addictive ,safe and easy to administer(6) .Therefore it is highly desirable to incorporate with the diabetic care routine.

II. MATERIALS AND METHODS:

This experimental study was conducted among the patients from both the sexes suffering from type 2 diabetic Mellitus for about 5 years after onset of disease (no.50) and 10 years after onset of disease (no.50) ,with an age and sex matched control group(no.50). Patient from both sexes suffering from peripheral neuropathy of diabetic origin were selected from established cases of T2DM Patients who belongs to the age of 30 to 50 years ,attending the Medicine OP of Kanyakumari Govt. Medical college Hospital Asaripallam.

Inclusion criteria:

The patients participated in the study had type 2 diabetes Mellitus and suffering from peripheral neuropathy with or without sensory manifestation. The muscle strength of upper limbs was not less than grade five according to manual muscle testing.

Exclusion criteria:

The patients excluded from this study had life threatening disease such as renal failure, myocardial infarction, malignancy or any other serious illness. Patients suffering from other possible causes of neuropathy or neuromuscular diseases for example, hypothyroidism, alcoholism, liver diseases, uses of drugs known to cause neuropathy or myopathy .

Instruments For Evaluation:

The Electro physiological test was done using Neuro stim 8 channeled polyrite. The patients were instructed about the procedure. A complete medical examination and detailed neurological examination were carried out for every patients such as examination, Visual Evoked Potential, Brain Stem Auditory Evoked Potential ,Height, Weight, Basal Pulse, Blood Pressure, Blood Sugar Level, HbA1c, Lipid Profile were evaluated.

Polyrite:

The Neurostim 8 channeled polyrite was utilized to study the median motor nerve conduction studies and median sensory nerve conduction studies before and after NMES treatment. The device consist of

Stimulating unit to which the stimulating electrodes was connected.

Amplifies to which the recording electrode and the ground electrode were connected.

Electrodes which consist of stimulating electrodes, ground electrode, two surface recording electrodes in which one is active and other is reference)

Procedure for Evaluation:

Visual Evoked Potential (VEP)

The subject was made to sit in a wooden chair at a distance of 70 – 100cm from the recording computer monitor. The recording room was made to dark. Recording for each eye was done separately. The skin where the electrode were placed was prepared by degreasing. The recording electrode was placed over the occipital prominence, the reference electrode was placed in the frontal region 12 cm above the nasion, and the ground electrode was placed over the vertex. The subject was asked to fix his gaze on the monitor which displays black and white checker board. The latency (stimulus to peak) and amplitude (positive to negative) of the waves were recorded.

For treatment:

All participants received an accumulated 30 minutes of Neuromuscular Electrical Stimulation at the motor point of median nerve of both the upper limb. The motor excitability allows the motor unit (consisting motor neuron and the muscle innervated by it) to depolarize and to repolarise inturn the muscle contracts and relax.

Procedure:

Neuromuscular Electrical stimulation was applied using mini muscle stimulator model DS7A,

The patients were seated comfortably on a chair with standard back support.

The upper limb was strapped to a custom designed hand force plate transducer to determine the velocity of contraction of elbow and the stimulus was given at the elbow portion of the median nerve for peripheral excitability. The NMES stimulator will deliver a set of electrical

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impulse of 25Hz, 800ms on /800ms off. The time that the stimulation is on and off, that is during the on time 800 ms the NMES stimulator will deliver a sequence of electrical impulse .The off time of 800ms is rest phase to prevent the muscle becoming over fatigued(6).

III. RESULT :

Section I: Baseline characteristics of the study population

The baseline parameters considered in this study are, age, height, weight, BMI and blood parameters of the study groups. Tabular presentation of baseline parameters in the study groups were given below.

Table 1: Demographic characteristics of the study groups

Variables	Control Group		5 Years of T2D		10 Years of T2D		Significance
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Age in years	37-50	43.31±4	37-48	42.31±3.68	45-50	48.38±1.65	0.289
Height in cm	149-164	155.96±4.26	149.8-163.8	156.24±4.46	149-165.5	158.68±4.52	0.943
Weight in kg	57-68	61.88±3.77	57-68	62.67±4.15	59-69.5	62.27±3.26	0.579
BMI kg/m2	19-26.4	22.43±2.32	19.5-26.4	23.04±2.11	19-29.30	22.07±2.84	0.139

ANOVA Test, $p<0.05$ shows statistical significance

The overall age varies from 30-50 years, In the patient group of T2DM with 5 years after onset of disease range of age was 37 to 48 years with an average of 42.31±3.68 years, and 10 years after onset of disease was 45-50 years with mean age of 48.38±1.65 years, and in the control group age varies from 37-50 years with an average age of 43.31±4 years. There is no significant difference were observed in age between the study groups (p=0.289). Anthropometric measures such as height (control Group: 155.96±4.26, T2DM 5: 156.24±4.46, T2DM 10 Years: 158.68±4.52) in cm, weight (control Group: 61.88±3.77, T2DM 5 years: 62.67±4.15, T2DM 10 Years: 62.27±3.26) in kg and BMI (control Group: 22.43±2.32, T2DM 5 years: 23.04±2.11, T2DM 10 Years: 22.07±2.84) Kg/m^2, were not significantly differ between the study groups (p>0.05).

Table 2: Distribution of blood parameters among the study groups

Variables	Control Group		5 Years of T2D		10 Years of T2D		Significance
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
FPG	70-100	86.9±9.12	100-153	136.79±10.25	126.5-162.1	146.56±10.14	<0.001*
HBA1c	3.89-5.60	4.89±0.59	5.60-8.60	7.31±0.63	4-9.50	7.79±1.16	<0.001*
TGD	0.90-5	1.69±1.03	0.90-2.50	1.77±0.4	0.90-2.60	1.72±0.5	0.851
HDL	1.02-1.54	1.18±0.14	0.80-1.30	1.13±0.13	0.90-1.20	1.05±0.11	<0.001*
LDL	1.96-2.63	2.41±0.16	1.60-2.90	2.25±0.3	1.50-3.20	2.22±0.53	0.023*
RHR	60-100	76.65±11.73	59-100	66.63±6.09	60-100	66.73±6.69	<0.001*
SBP	112-120	117.71±2.48	118-130	122.81±3.3	118-135	124.98±5.4	<0.001*
DBP	70-80	77.14±2.74	68-83	77.69±4.35	80-86	83.65±5.08	<0.001*

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ANOVA Test, p<0.05 shows statistical significance

Blood parameters we considered in this study are FPG, HbA1c, TGD, HDL, LDL, RHR, SBP and DBP. All parameters show abnormality in patient groups, and its more verse in 10-year group, and both patient groups are statistically significantly differing with control group (p<0.001) except the parameter TGD (p>0.05).

Table 3: Distribution of blood parameters after NMES among the study groups

Variables	T2D of 5 years after NMES		T2D of 10 years after NMES	
	Range	Mean±SD	Range	Mean±SD
FPG	124-153	137.96±8.99	131.8-210.8	151.46±16.9
HBA1c	6.2-8.6	7.36±0.61	6.4-9.5	7.89±0.99
TGD	0.9-2.5	1.78±0.4	1.2-2.6	1.98±0.4
HDL	0.8-1.3	1.13±0.13	0.9-1.2	1.05±0.11
LDL	1.6-2.9	2.24±0.3	2.63-4.82	3.82±0.71
RHR	59-73	65.88±3.64	60-75	66.17±4.51
SBP	118-130	123.04±3.44	120-129	123.5±2.64
DBP	68-83	78.13±4.25	78-86	81±2.36

Table 3 shows descriptive presentation of post-operative blood parameters after NMES. From the results we can observe that the average values are more in 10-year group.

Section II : Comparison of different Electrophysiological parameters of Nervous system of type 2 Diabetes Mellitus patients at 5 years, before and after neuro muscular electrical stimulation

This section deals with the pair wise comparison of treatment groups before and after neuro muscular electrical stimulation of T2DM patients after 5 years of onset of disease. We have considered 50% of both patient groups to underwent NMES and observed the post test results of these electrophysiological parameters. For normal data we have used paired T test and for non-normal data Wilcoxon signed rank test were done. Line diagram are used to represent the change in pre-test to post test, and a p value less than 0.05 shows statistical significance. The tabular and graphical presentation of data are given below.

Table 4: Comparison of VEP N75, P100, N145, N75-P100 of Right eye of T2DM patients within five years with before and after NMES in the median Nerve

Variables	T2DM within 5 years Right eye (Mean±SD)			Significance
	Pre test	Post test	Paired difference	
VEP N75	74.19±2.73	74.99±0.95	-0.8±2.9	.187
P100	99.1±1.28	99.61±0.62	-0.5±1.62	.141
N145	150.63±3.09	151.32±3.05	-0.69±4.89	.498
N75-P100	5.06±0.41	5.2±0.22	-0.14±0.47	.168

Wilcoxon Signed Rank Test, p<0.05 shows statistical significance

Graph 1: Distribution of VEP N75, P100, N145, N75-P100 of Right eye of pre-post assessment on NMES

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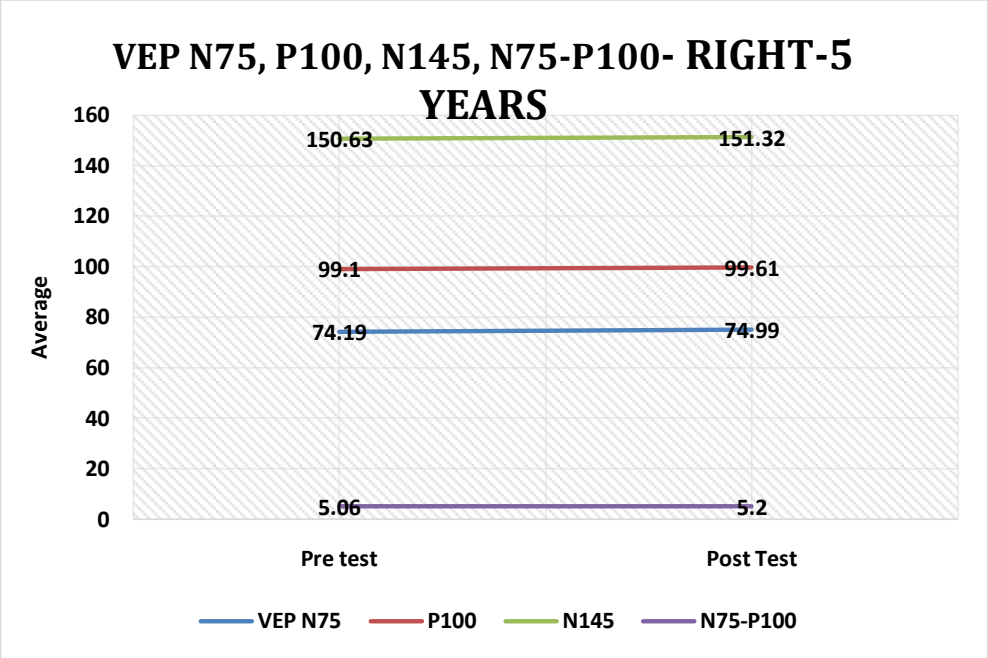

Table 4 and line diagram (Graph 1) shows pretest to posttest comparison of Latency N75, Latency P100, Amplitude N75, Amplitude P100 of Visual Evoked potential of Right eye of the type 2 Diabetes Mellitus patients within five years after the onset of disease after NMES in the median Nerve. There is no statistically significant difference were observed in these parameters after the treatment ($p>0.05$) and thus we can conclude that NMES doesn't make any significant changes in VEP N75, P100, N145, N75-P100 of Right eye.

Table 5:Comparison of VEP N75, P100, N145, N75-P100 of Left eye of T2DM patients within five years with before and after NMES in the median Nerve

Variables	T2DM within 5 years left eye (Mean±SD)			Significance
	Pre test	Post test	Paired difference	
VEP N75	83.2±2.44	82.17±2.86	1.03±3.38	0.149
P100	127.23±1.53	127.15±1.57	0.08±2.49	0.884
N145	3.16±0.2	3.1±0.22	0.06±0.3	0.334
N75-P100	160.56±4.43	159.77±4.45	0.79±4.16	0.361

Wilcoxon Signed Rank Test, $p<0.05$ shows statistical significance

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Graph 2: Distribution of VEP N75, P100, N145, N75-P100 of Left eye of pre-post assessment on NMES

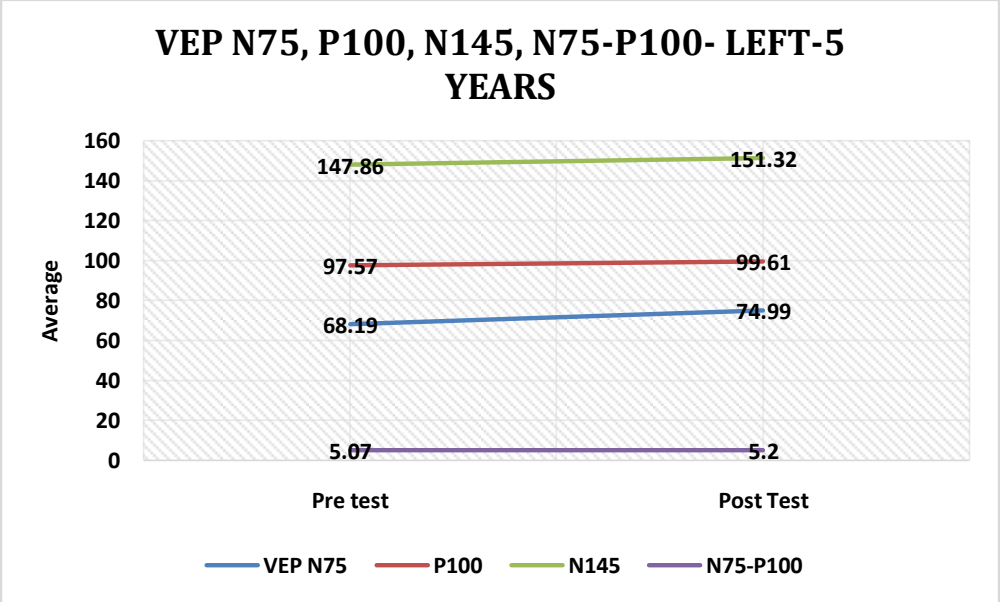

Table 5 and line diagram (Graph 2) shows pretest to posttest comparison of Latency N75, Latency P100, Amplitude N75, Amplitude P100 of Visual Evoked potential of left eye of the type 2 Diabetes Mellitus patients within five years after the onset of disease after NMES in the median Nerve. There is no statistically significant difference were observed in these parameters after the treatment ($p>0.05$) and thus we can conclude that NMES doesn't make any significant changes in VEP N75, P100, N145, N75-P100 of Left eye.

Section III :Comparison of different Electrophysiological parameters of Nervous system of type 2 Diabetes Mellitus patients at 10 years, before and after neuro muscular electrical stimulation

This section deals with the pair wise comparison of treatment groups before and after neuro muscular electrical stimulation of T2DM patients after 10 years of onset of disease. We have considered 50% of both patient groups to underwent NMES and observed the post test results of these electrophysiological parameters. For normal data we have used paired T test and for non-normal data Wilcoxon signed rank test were done. Line diagram are used to represent the change in pre-test to post test, and a p value less than 0.05 shows statistical significance. The tabular and graphical presentation of data are given below.

Table 6 :Comparison of VEP N75, P100, N145, N75-P100 of Right eye of T2DM patients within Ten years with before and after NMES in the median Nerve

Variables	T2DM within 10 years Right eye (Mean±SD)			Significance
	Pre test	Post test	Paired difference	
VEP N75	68.19±0.5	74.99±0.95	-6.8±1.19	<0.001*
P100	97.57±0.54	99.61±0.62	-2.04±0.83	<0.001*
N145	147.86±0.62	151.32±3.05	-3.46±3.1	<0.001*
N75-P100	5.07±0.16	5.2±0.22	-0.13±0.27	0.032*

Paired T Test, $p<0.05$ shows statistical significance

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Graph 3 : Distribution of VEP N75, P100, N145, N75-P100 of Right eye of pre-post assessment on NMES

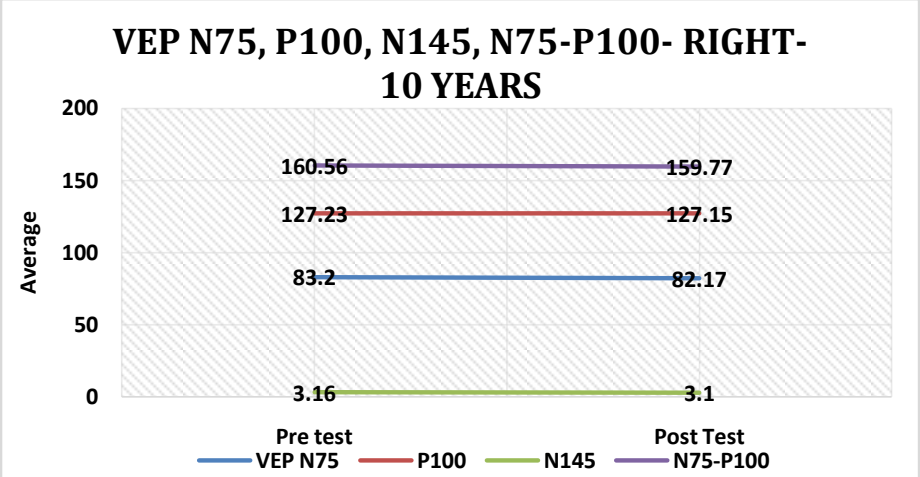

Table 6 and line diagram (Graph 3] shows pretest to posttest comparison of Latency N75, Latency P100, Amplitude N75, Amplitude P100 of Visual Evoked potential of Right eye of the type 2 Diabetes Mellitus patients within ten years after the onset of disease after NMES in the median Nerve. We have observed minor change in all parameters from pre-test to post test and this observed difference was statistically significant ($p<0.05$) and thus we can conclude that NMES makes significant changes in VEP N75, P100, N145, N75-P100 of Right eye.

Table 7 :Comparison of VEP N75, P100, N145, N75-P100 of Left eye of T2DM patients within Ten years with before and after NMES in the median Nerve

Variables	T2DM within 10 years left eye (Mean±SD)			Significance
	Pre test	Post test	Paired difference	
VEP N75	83.44±2.39	82.17±2.86	1.27±3.64	0.100
P100	127.15±1.34	127.15±1.57	-0.01±2.19	0.990
N145	161.75±4.35	159.77±4.45	1.98±6.94	0.180
N75-P100	3.19±0.18	3.1±0.22	0.1±0.32	0.140

Wilcoxon Signed Rank Test, $p<0.05$ shows statistical significance

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Graph 4: Distribution of VEP N75, P100, N145, N75-P100 of Left eye of pre-post assessment on NMES

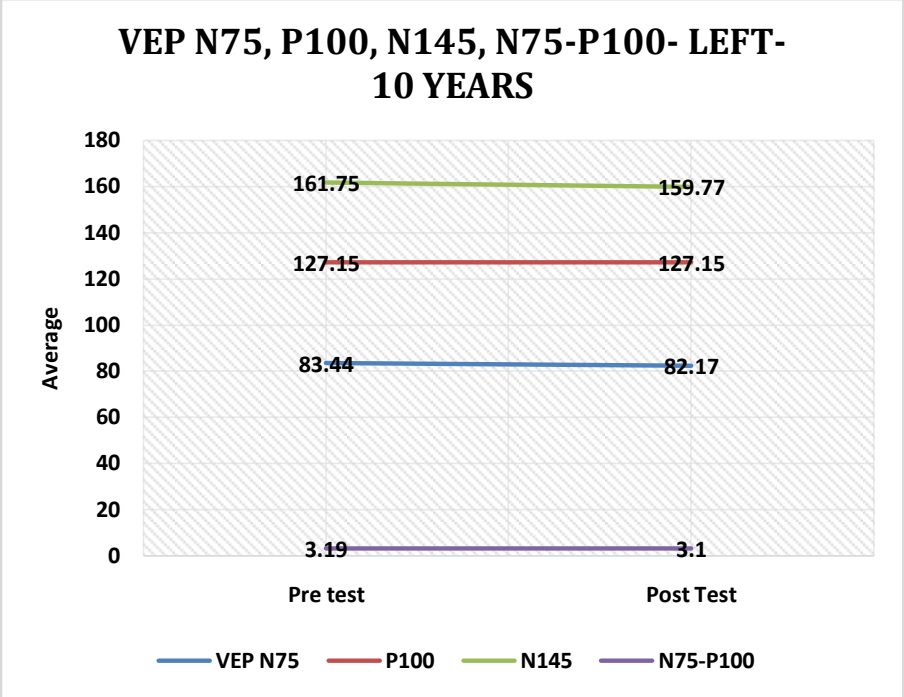

Table 7 and line diagram (Graph 4) shows pretest to posttest comparison of Latency N75, Latency P100, Amplitude N75, Amplitude P100 of Visual Evoked potential of left eye of the type 2 Diabetes Mellitus patients within ten years after the onset of disease after NMES in the median Nerve. There is no statistically significant difference were observed in these parameters after the treatment ($p>0.05$) and thus we can conclude that NMES doesn't make any significant changes in VEP N75, P100, N145, N75-P100 of Left eye.

IV. DISCUSSION:

This study showed that a 10 week NMES exercise programme improved the body composition, glyceamic control, significant reduction in fasting glucose , improvement in the nerve conduction parameters were noted in T2DM participants. Lowering fasting plasma glucose levels is strongly associated with reductions in the risk of complications .However, the change in fasting plasma glucose levels after the NMES intervention are modest, fasting plasma glucose levels correlate poorly with HbA1c.

Latency N75, Latency P100, Amplitude N75, Amplitude P100 of Visual Evoked potential of Right eye of the type 2 Diabetes Mellitus patients within five years after the onset of disease after NMES in the median Nerve. There is no statistically significant difference were observed in these parameters after the treatment and thus we can conclude that NMES doesn't make any significant changes in VEP N75, P100, N145, N75-P100 of Right eye. Pretest to post test comparison of Latency N75, Latency P100, Amplitude N75, Amplitude P100 of Visual Evoked potential of Right eye of the type 2 Diabetes Mellitus patients within ten years after the onset of disease after NMES in the median nerve We have observed minor change in all parameters from pre-test to post test and this observed difference was statistically significant ($p<0.05$) and thus we can conclude that NMES makes significant changes in VEP N75, P100, N145, N75-P100 of Right eye. Exercise is a vital component in the management and prevention of T2DM , but many individuals with T2DM patients face barrier to exercise to conventional exercise. However prior to this study , there has been a lack of evidence showing the beneficial effects of prolonged NMES intervention on electrophysiology of peripheral nervous system .

Electrophysiological tests support the measurement of speed of both sensory and motor conductions, the amplitude of the propagating neural signal, the density and synchrony of muscle fibres activated by maximal nerve stimulation and the integrity of neural transmission(7).

Therefore Nerve electrophysiological procedures have emerged as an important method of tracing of onset and progression of Diabetic peripheral neuropathy (8). According Kumar and co authors (9) Electrical stimulation for painful

neuropathy ,there was a significant improvement in neuropathic symptoms. In the studies of Bosi and coauthors reported that there is improvement in the vibration sensation and other sensations after the electrical stimulation (10).From the above studies it is clear that the electrical stimulation improved the symptoms of neuropathy.This study was similer to chih- Chung et al ,The neuromodulation of motor excitability has been shown to improve functional movement in people with central nervous system damage.(11)

Application of NMES is considered to be an better treatment option for large and small fibre neuropathy. This device sends tiny electrical signals to the motor nerves and muscles. As these signals are exactly like the normal nerve signals but much larger and is not dangerous or harmful, these are able to wake up sleeping nerves and strengthens muscles by increasing muscle tone and blood circulation(12). It opens up the nerve paths, which returns these paths for passing normal signals. Thus NMES helps in improvement of neuropathy by, Stimulating the muscles to contract and relax , thereby increasing blood velocity and volume, increasing collateral circulation and stimulating vasogenesis(13), Stimulating all the afferent and efferent nerves with signals larger than normal to re establish the pathway for subsequent normal signal to follow, Draws axon and dendrite of nerve endings closer together to facilitate proper nerve transmission, Builds residual pain relief each time the system is used, Causes the brain to release endorphins that reduce global pain and anxiety(14), Increases muscle strength for safe pain free walking, promotes better mobility and balance during the course of treatment15,16), Reduces edema as muscle contraction encourage lymphatic drainage. Thus the NMES is a noval intervention for improvement in the electrophysiology of peripheral nervous system.

V. CONCLUSION:

NMES training method is efficient for alternate exercise method to maintaining the electrophysiology of nervous system and can induce greater change in the DNP and blood glucose level, blood pressure. Body fat for theT2DM Patients, who might have difficulties in performing adequate voluntary exercise. In the future it would be interesting to compare different intensities of voltage, frequency and duration and analyze the nerve electrophysiological properties during diabetic condition

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