

Effect of Balance and Core Strengthening Exercise on Fall, Activities of Daily Living and Quality of Life in Patients with Diabetic Peripheral Neuropathy - An Experimental Study

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ABSTRACT

Background: Diabetic peripheral neuropathy [DPN] is one of the long-term complications of diabetes caused by peripheral motor and sensory nerve dysfunction. The estimated prevalence globally of DPN is 13-68%.^[3] Around 50% of diabetic patients with type 2 diabetes mellitus suffer from neuropathy. DPN disturbs the sensory and motor control system which eventually generation and control of the gait. Gait mechanics may be affected as a result. Reduce ROM, muscle strength and changes in gait mechanics [gait cycle, reduced cadence and gait speed] can lead to reduce mobility and increase fall of risk. Sensory and motor deficit are affected due to somatosensory changes which lead to continuous falling during activities of daily living.

Aim: To study the effect of balance and core strengthening exercise on fall, activities of daily living and quality of life in patients with diabetic peripheral neuropathy.

Methodology: The nature of the study and the intervention were explained to the participants. Their informed written consent was taken. 51 participants were selected based on the selection criteria. Prior and after the treatment the outcome measures that is Fall efficacy scale, Instrumental activities of daily living and Nottingham health profile were taken. Intervention protocol was given for 1 hour, 3 times a week for 4 weeks.

Outcome measures: Prior and after the treatment both the outcome measures, Fall efficacy scale, Instrumental activities of daily living and Nottingham health profile were taken.

Results: In reference to the results of the Wilcoxon test analysis at 5% significance level, there is a significant statistical reliable difference between the pre & post treatment values with p-value is less than the 5% significance level (i.e., $0.001 < 0.05$) in the study and therefore it justifies the improvements in health outcome post intervention.

Conclusion: The present study concluded that balance exercises and core strengthening exercises proved to be beneficial for fall prevention and improving activities of daily living and quality of life in patients with diabetic peripheral neuropathy.

Key words: Diabetic peripheral neuropathy, Core strengthening, Balance, Risk of fall, Activities of daily living, Quality of life.

INTRODUCTION

Diabetic peripheral neuropathy [DPN] is one of the long-term complications of diabetes caused by peripheral motor and

sensory nerve dysfunction. It is the most common chronic complication which can lead to mortality and morbidity in individuals with diabetes. DPN is a

progressive degeneration of the peripheral nerves particularly in lower limbs which further results in loss of protective sensation, intrinsic foot muscle dysfunction and anhidrosis of the foot.^[1] More than 220 million people worldwide have diabetes.^[2] The estimated prevalence globally of DPN is 13-68%. Around 50% of diabetic patients with type 2 diabetes mellitus suffer from neuropathy.^[3]

DPN has been linked to lower levels of activity in older persons, as measured by steps per day. Moreover, the associated sensory impairments, along with accelerated arterial disease, result in an increased susceptibility of lower extremities to injury and infection, which can result in diabetic amputations.^[1] It causes progressive loss of vibratory, thermal, tactile, proprioceptive sensitivities, following this sequence of incidence.^[2] Previous studies show that patient with diabetic peripheral neuropathy suffer from balance impairment and gait deviation.^[3,4] DPN primarily affects small or large fibers afferent-efferent axons which leads to diminished proprioceptive sensations leading to ankle position sense. Hence individual suffers from increased risk of fall or impaired balance.^[6] Patients with DPN are fifteen times more likely to report a fall related injury during standing and walking as compared to people without diabetes.^[5] There is an increase in dynamic balance sway, in addition to increase muscular effort to maintain balance is the potential risk of falling for the patients with DPN.

DPN disturbs the sensory and motor control system which eventually generation and control of the gait. This can lead to changes in gait mechanics.^[1] DPN related changes in lower limb may cause functional gait variations specifically related to reduce range of motion of joints, reduce active muscle affects the quality and quantity of the sensory information that is involved in the power and changes in mechanics which further reduces kinematics and kinetics of lower limb. Reduction in muscle strength around the ankle joint specifically tibialis

anterior, may be responsible for the gait deviation in diabetic patients. Peroneal nerve which innervates tibialis anterior muscle is the first nerve to show electrophysiological alteration in patients with DPN. DPN also reduces strength of ankle plantar flexors which lead to adaptation of hip strategy and hence the leg is pulled forward from the hip using the flexor muscle, rather than being pushed forward by the foot using plantar flexor muscle [ankle strategy]^[3] Reduce ROM, muscle strength and changes in gait mechanics [gait cycle, reduced cadence and gait speed] can lead to reduce mobility and increase fall of risk.^[1]

Sensory and motor deficit are affected due to somatosensory changes which lead to continuous falling during activities of daily living.

Several rehabilitation approaches were used for the treatment of DPN which included pharmacological drugs, manual therapy, electrotherapy modalities, acupuncture and exercise therapy. Among this exercise therapy had a great attention on improvement of the great function.^[1] In exercise therapy core stability exercise is one of the effective interventions for improving postural stability in patients with DPN.^[4]

Balance is described as the ability to keep the body's centre of gravity within its base of support, and it can be classified as static or dynamic balance. Because it demands the ability to maintain equilibrium throughout a transition from a dynamic to a static state, dynamic balancing is thought to be more difficult. Both static and dynamic balance necessitate the efficient integration of visual, vestibular, and proprioceptive inputs in order to generate an efferent response that controls the body within its base of support. Any disruption or deficit in the sensorimotor system can cause a loss of balance, which can lead to harm. Enhanced balance training exercises are intended to boost confidence, mobility, and daily functioning. Balance training includes equilibrium control exercises that are repetitive and graded in

complexity that enhance balance by improving sway control and inhibiting inappropriate motor responses.^[2]

Many muscles support the lumbo-pelvic-hip complex, which are referred to as "core muscles." Faries and Greenwood provided definitions of "core stability," referring to the ability to stabilize the spine as a result of local muscle activity. Key emphasized stabilizing co-contraction increasing intra-abdominal pressure via the control of local core muscles as the "stabilization synergy" of the core. "Core stability training" is introduced from the activation of the TrA as a primary local muscle in the "core" muscles.^[4]

Core stability describes the movement of the center portion of the body and the ability to control the position. Core stability training targets the muscle deep within the abdomen that assist in the maintenance of good posture and provide the foundation for all leg and arm movements. This exercise allows the body to maintain its balance by improving the strength of core muscle.^[4]

Hodges and Jull and Comerford and Mottram proposed stepwise exercises from local muscles to global muscles and integration of these groups in stability training. Some researchers have reported that core stability training could improve not only trunk function but also balance and mobility.^[7]

In diabetic peripheral neuropathy patients, it is seen that the impaired balance and altered gait pattern increases the risk of fall. Previous studies have shown that exercise therapy has improved the limit of stability in diabetic peripheral neuropathy. But there is lack of literature to see the effect of balance and core strengthening exercise on fall, activities of daily living and quality of life which is considered to be the important factor in patients' life. Thus, my need of study is to see the effect of balance and core strengthening exercise on fall, activities of daily living and quality of life in patients with DPN.

MATERIALS

- Stopwatch.
- Chair.
- Medicine ball (1Kg)

METHODOLOGY

- Type of study: Experimental study.
- Study design: pre and post experimental design.
- Study duration: 6 months.
- Type of sampling: convenient sampling.
- Sample size: 51
- Study setting: tertiary care hospital in Miraj.

PROCEDURE

- The institutional ethical committee granted permission to proceed.
- Subjects will be selected according to the inclusion criteria. Prior to the study subjects will explained the procedure.
- A written informed consent will be taken from the subjects prior to study.
- Prior and after intervention all the outcome measures that is Fall efficacy scale, Instrumental activities of daily living, Nottingham health profile will be measured.
- Intervention will be given for 1 hour, 3 times a week for 4 weeks.

INTERVENTION

- Warm up exercise for 10 minutes.
- Slow walking.
- Stretching of all joints and major muscles.

EXERCISE THERAPY

- Balance Training Exercise
- Standing with narrow base of support.
- Standing in tandem walking.
- Standing on single leg.
- Standing on heel.
- Standing on toes.

All the above exercise should be performed 3times for 30 seconds.

CORE STABILITY EXERCISE

- Bridging exercise.
- Cat camel exercise.

- Abdominal crunch and oblique crunches.
- Opposite arm and leg exercise.
- Twist exercise.
- **All The Above Exercise Should Be Performed 10 Times For 3sets.**
- Plank exercise

FOR 10 SECONDS 3 TIMES

- Cool down exercise for 10 minutes.
- Stretching of all main muscle groups and joints.

STATISTICAL ANALYSIS

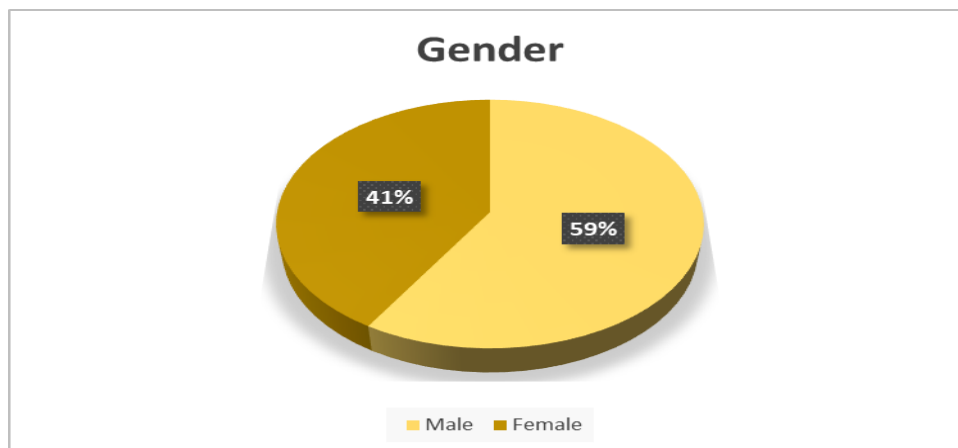
The Statistical Package for Social Sciences [SPSS] software was used to analyse the data. The level of significance for PRE and POST test for Fall efficacy scale, Instrumental activities of daily living,

Nottingham health profile was calculated using Wilcoxon test.

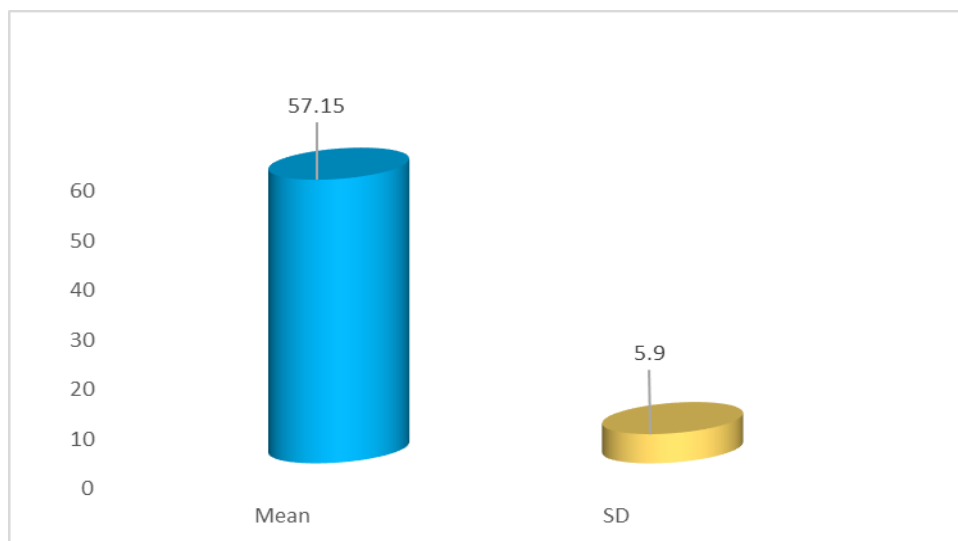
RESULTS

The Statistical Package for Social Sciences [SPSS] software was used to analyse the data. The level of significance for PRE and POST test for Fall efficacy scale, Instrumental activities of daily living, Nottingham health profile was calculated using Wilcoxon test.

For this study, 51 participants with diabetic peripheral neuropathy with $HbA1c \leq 6\%$ were included. To check the risk of fall, activities of daily living and quality of life, scales such as Fall efficacy scale, Instrumental activities of daily living, Nottingham health profile were used.



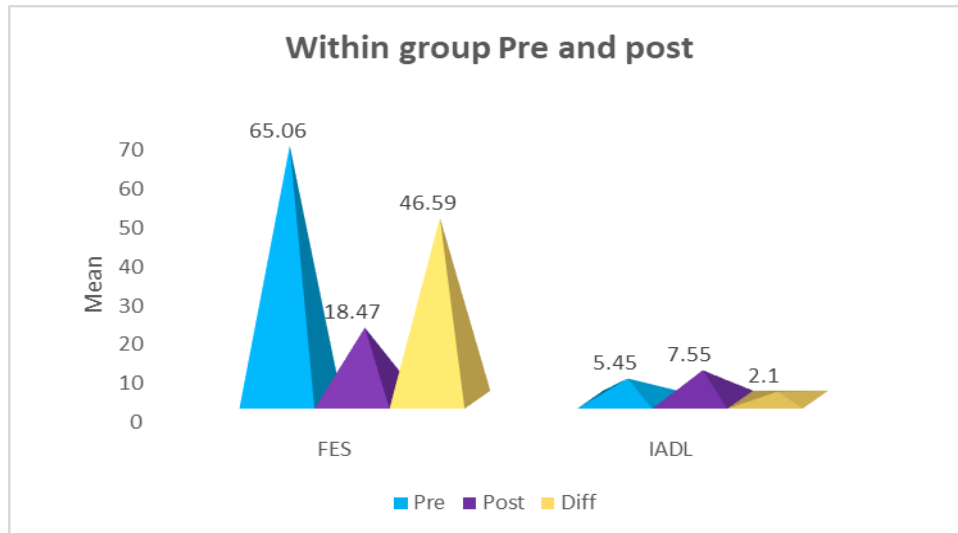
Graph No.1.: Shows percentage of male and female distribution



Graph No.2.: Shows Mean and Standard Deviation of Baseline Data [Age].

Table no.1.: Shows the mean, standard deviations, z-value and p-value of the outcome measures FES and IADL, pre and post test respectively.

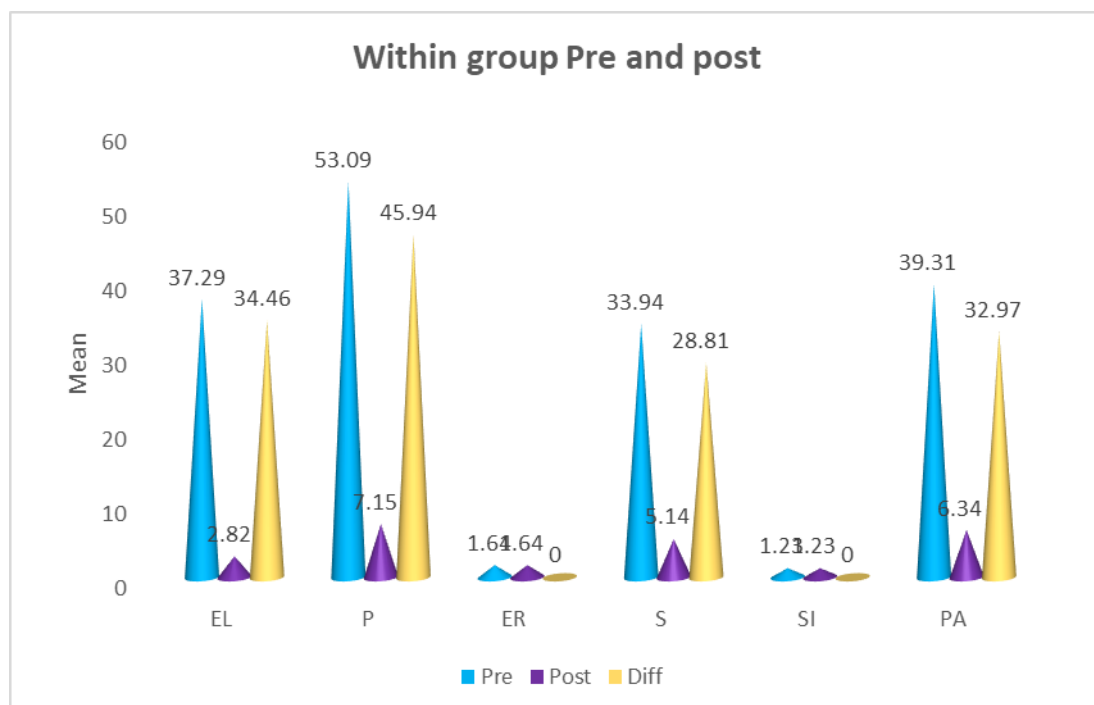
Variable	Pre		Post		Diff		Effect size	z –value	p –value
	Mean	SD	Mean	SD	Mean	SD			
FES	65.06	10.28	18.47	8.71	46.59	6.90	6.75	48.200	0.001*
IADL	5.45	1.30	7.55	0.50	2.10	1.01	2.09	14.907	0.001*



Graph No.3.: Shows mean value of pre, post and difference of the outcome measures FES and IADL respectively.

Variable	Pre		Post		Diff		Effect size	z –value	p –value
	Mean	SD	Mean	SD	Mean	SD			
EL	37.29	23.31	2.82	7.81	34.46	20.66	1.67	11.913	0.001*
P	53.09	14.10	7.15	4.43	45.94	11.60	3.96	28.285	0.001*
ER	1.64	6.84	1.64	6.84	NA	NA	NA	NA	NA
S	33.94	14.45	5.14	6.51	28.81	11.31	2.55	18.189	0.001*
SI	1.23	6.55	1.23	6.55	NA	NA	NA	NA	NA
PA	39.31	12.77	6.34	5.38	32.97	10.13	3.25	23.242	0.001*

Table no.2.: Shows the mean, standard deviations, z-value and p-value of the outcome measure Nottingham health profile, pre and post test respectively.



Graph No.4.: Shows mean value of pre, post and difference of the outcome measure Nottingham health profile respectively.

Results From Analysis

From the above within groups' analysis using Wilcoxon paired test, it is observed that EL mean value indicated changes post treatment and lower mean values are recorded for post treatment outcome and also the standard deviation shows the consistency with post treatment value which is less than pre value.

The effect size Cohen's D indicates 6.75, 2.09, 1.67 value which is assumed to be very high in effect size as per the standard parameters of reference.

Thus, reference to the results of the Wilcoxon test analysis at 5% significance level, there is a significant statistical reliable difference between the pre & post treatment values with p-value is less than the 5% significance level (i.e. $0.001 < 0.05$) in the study and therefore it justifies the improvements in health outcome post intervention.

This states that balance and core strengthening exercises are very effective for fall prevention and improving activities of daily living and quality of life in patients with diabetic peripheral neuropathy.

DISCUSSION

The result of the present study demonstrated that balance and core strengthening exercises are very effective for fall prevention and improving activities of daily living and quality of life in patients with diabetic peripheral neuropathy.

Core stability exercises targets the muscles deep within the abdomen that assist in the maintenance of good posture and provide the foundation for all arm and leg movements. It allows the body to maintain its balance by improving the strength of core muscles. Because core stability exercises increase torso muscle performance while also improving dynamic balance, any training that substitutes for reduced balance may help individuals with diabetic peripheral neuropathy improve standing postural control and posture stability. Additionally, core stability exercises aid in the activation of core muscles prior to lower

limb movement as a positional feed forward reaction by the central nervous system to minimise positional deficits, which improves dynamic body balance, trunk function, and reduces the chance of falling.

Balance is an important parameter that is useful in our daily life activity. Balance is controlled by the feedback mechanism of the combined muscle action which depends on the postural sway information that is obtained from visual, motor, sensory, and vestibular receptors. The impairment in the body balance was found in the anteroposterior plane. The affection of the balance is due to the dynamic postural sway and in addition to increased muscular effort to maintain the balance in diabetic patients with neuropathy. Balance exercise mainly focus on the sense of joint position that helps to maintain joint stability and posture that helps to improve somatosensory system which is affected in subjects with DPN.

Gehan M Ahmed et.al. (2018) found out the effect of core stability exercise and desensitization therapy on the limit of stability in diabetic peripheral neuropathy patients. 60 patients with DPN with average age 55-70 years were included in the study. The patients were randomly divided in 4 equal groups. The intervention was given 3 times a week for 6 weeks. Outcome measures used were biodex balance system. In this study core stability exercise and desensitization therapy enhance the stability of patients with diabetic peripheral neuropathy.^[4]

Another study done by Haimanot Melese et.al. (2020) was to review the effectiveness of exercise therapy on gait function in patients with diabetic peripheral neuropathy. Outcome measures used were six-minute walk test, 10-meter walk test and Tinetti scale. A total of 370 people took part in nine randomised controlled trials. Out of them eight studies proved its effectiveness on gait function on individual with diabetic peripheral neuropathy. The findings of this study shows that multi component exercise therapy consisted of strength, ROM exercise, balance, flexibility and stretching

exercise, circuit exercise training and gait training found to enhance gait function for individuals suffering with diabetic peripheral neuropathy compared to the control group.^[8]

A study was done on the effect of rehabilitation program on gait of diabetic peripheral neuropathy patients by Basant Hamdy El-refay et.al. (2014). Thirty patients with diabetic peripheral neuropathy were randomly divided into an intervention group (n=15) and control group(n=15). The intervention consisted of an exercise program including ROM, muscle strengthening, balance and gait training exercise (3 days weekly for 8 weeks). Control group received only usual recommended medical care. Spatiotemporal parameters and ankle joint range of motion during the stance phase of gait were measured using Qualisys motion capture system pre and post intervention. The intervention program increased significantly walking speed, cadence and ankle range of motion with significant decrease of step time, while for the control group no significant difference was noted.^[5]

Another study conducted by Steven J. Brown et.al. (2015) aimed to assess balance during the dynamic daily activities of walking on level ground and stair where falls are most likely to occur. Gait analysis during level walking and stair ascent and descent were performed in 22 patients with DPN, 39 patients with diabetes without neuropathy and 28 non diabetic control subjects using a motion analysis system and embedded force plates in a staircase and level walking. Balance was assessed by measuring the separation between the body center of mass and center of pressure during level walking, stair ascent and stair descent. DPN patients showed maximum range of separation of their center of mass from their center of pressure as compared to the non-diabetic subjects.^[9]

A study was done to compare the quality of life of diabetic patient who is suffering from DPN and non-diabetic patients by S.J. BENBOW et.al. (1998). 79 subjects with

diabetes and 37 non diabetic subjects were taken. Quality of life was assessed by using Nottingham Health Profiles present. Symptomatic DPN was present in 41 patients. The neuropathy patients had significantly higher score than diabetic patients than non-diabetic patients.^[10]

CONCLUSION

In DPN, somatosensory changes cause sensory and motor deficit which leads to continuous falling during activities of daily living thus affecting the quality of life.

The present study concluded that balance exercises and core strengthening exercises proved to be beneficial for fall prevention and improving activities of daily living and quality of life in patients with diabetic peripheral neuropathy.

Hence concluding that balance exercises and core strengthening exercises are effective, simple and easy, so it can be implemented clinically as well.

To maintain obtained benefits for a longer period of duration, periodic repetition of the intervention is recommended.

Limitations And Suggestions

• Limitations:

1. Proper distribution of males and females can be done.
2. Patients only with HbA1c<=6% were included in the study.

• Suggestions:

1. Study can be done in other population.
2. Study can be done on larger population.
3. Patients with HbA1c>6% can also be included in the study.

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Conflict of Interest: None

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Ethical Approval: Approved

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