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Research Article

Efficacy of 4 Weeks of Otago Exercise Programme in Improving Balance and Reducing Fall Risk in Persons with Diabetic Neuropathy

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I N F O

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A B S T R A C T

Background: Numbness, tingling, pain and weakness are common in Diabetic Neuropathy patients and these symptoms often start in their feet before spreading proximally in a length-dependent manner. This results in a decrease in balance which leads to increased risk of fall and reduced quality of life. Otago Exercise Programme (OEP) is an individually tailored, home-based, balance and strength fall prevention programme that helps to improve balance in the elderly population. This study was conducted to determine if four weeks of OEP had any impact on balance and falls in diabetic neuropathy patients.

Materials and Method: A total of 32 participants aged between 40 and 70 years with diabetic neuropathy were randomly recruited from various hospitals of Kamrup Metro, Assam. OEP, which consists of 17 strength and balance exercises, was done for 4 weeks and the outcome measures were assessed using the Berg Balance Scale (BBS), Timed up and go test (TUG) and Falls Efficacy Scale (FES).

Results: Wilcoxon paired test was used to find any significant differences between pre- and post-intervention values of BBS, TUG and FES (p value < 0.001). The effect sizes (ranging from 0.86 to 0.89) indicated large effects for all three scales, suggesting substantial improvements in balance, efficacy, and mobility post-intervention.

Conclusion: OEP was found to be effective in improving balance in diabetic neuropathy, thus reducing the risk of falls in these patients.

Keywords: Otago Exercise Programme, Berg Balance Scale, Falls Efficacy Scale, Diabetic Neuropathy

Introduction

Diabetic neuropathy (DN) is a variety of clinical or subclinical symptoms caused by diabetes mellitus (DM) that damage the peripheral nervous system.[1] The widely frequent condition of DN has a significant impact on patients by raising the risk of falls, lowering quality of life and causing pain. This condition is marked by significant morbidity and a loss of sensory function that starts far in the lower limbs.[2] Individuals with Type 2 Diabetes Mellitus have a higher rate of neuropathy than those with Type 1 Diabetes Mellitus.[3] Up to 50% of people with diabetes will ultimately develop neuropathy during the course of their illness, as per Western literature. The International Diabetes Federation's most recent statistics indicate that

8.3% of people worldwide have diabetes.[4] In 2017, India had 72,946,400 patients, making it the nation with the 2nd highest number of diabetics.[5] In those between the ages of 40 and 59 years, DM cases are most prevalent.[6] According to the research conducted in India, the occurrence of peripheral neuropathy in diabetes patients ranges from around 10.5% to 32.2%.[7] Numbness, tingling, discomfort, and weakness are characteristic symptoms of DN patients, and they often start in the feet before spreading proximally in a glove and stocking fashion.[8] Diabetes and pre-diabetes change the body's structure leading to progressive degeneration of large myelinated fibres (Aα, Aβ) as well as small unmyelinated fibres (C) and sparsely myelinated (Aδ) fibres.[9] Small blood vessels seem to be damaged by persistently high blood serum glucose, which impairs the neurons' capacity to absorb oxygen and nutrients.[10] Amputations of the toes, foot, or leg, infections of the foot, dizziness, falls, failure to thrive, dehydration and pain are common in people with diabetic peripheral neuropathy (DPN).[11] Reduced walking speed and other gait abnormalities are common in people with DPN. Somatosensory loss in the legs impairs functional postural stability and increases the falling risk when engaging in more strenuous everyday activities.[12] Compared to adults of similar ages, those with DPN sway more quickly and with a wider range of motion in the medial-lateral and anterior-posterior directions.[13] A major factor in falls is a loss of equilibrium. A variety of outcome measures have been applied in clinical settings to evaluate patients' balance like the clinician-administered Timed Up & Go Test and Berg Balance Scale.[14] The OEP is an individualised, at-home fall prevention programme that focuses on balance and strength. Professors Melinda M. Gardner, John Campbell and Clare Robertson, Researchers at the "University of Otago in Dunedin," New Zealand, created the programme in response to the severity and frequency of all injuries among elder citizens in New Zealand.[15] The neural function is improved by regular exercise. According to studies, training that incorporates both resistance and aerobic exercise significantly lessens neuropathic symptoms and pain, increases muscle fibre, and enhances walking stability and strength.[16] It is a programme that includes strength exercises of moderate intensity that concentrate on the lower limbs and balance and should be executed for about 60 minutes at least three times a week. Also included can be walking on different days of the week, at least twice. The danger of falling is reduced as a result of this sort of programme's great effectiveness in improving lower limb balance, gait, and muscle strength.[17] However, no studies have been conducted to specifically examine the effectiveness of OEP in patients with DPN. So, this research aimed to study the efficacy of 4 weeks of Otago exercise in improving balance and reducing fall risk in DN patients.

Materials and Method

The study was conducted in various hospitals and diabetic clinics of Kamrup Metro, Guwahati, Assam from January 2023 to May 2023. An experimental pre-post study design was used. The Institutional and Ethical Committee for Human Research of The Assam Royal Global University approved this research (No: RGU/IEC HR/MPT/2023/05). All the experimental procedures were explained and written informed consent was obtained. A data collection form was provided to the participants. Participants were screened on the basis of the inclusion and exclusion criteria. Clinically diagnosed with DN, both males and females aged 40 to 70 years with lower limb muscle strength not less than grade 3 were included in this study. Subjects with plantar ulcer, any vestibular disorder causing dizziness, or postural hypotension were excluded. A total of 32 patients participated in this experimental study. Table 1 shows the demographic characteristic of the patients. Prior to the treatment, patients were assessed using the Berg Balance Scale, Falls Efficiency Scale, and TUG test scores.

Table 1.Baseline Characteristics of Patients

Age (Years)	Mean	Standard Deviation
Male	54.11	9.01
Female	57.00	9.85
Gender	**Number**	**Percentage**
Male	13	40.6
Female	19	59.4

Intervention

Four weeks of OEP was performed for 45–60 minutes on each subject, 3 times a week and the patients were encouraged to walk on the alternate days. Balance training, muscle strengthening and walking are the three domains of the OEP (Table 2). OEP started with back extension, head movements, and ankle and trunk movement. The exercises for muscle strengthening included side hip, back knee and front knee strengthening exercises, calf raises, and toe raises. Balance training included knee bending, turning and walking around, backwards walking, heel-toe walking, sideways walking, heel-toe stand, one-leg stand, tandem walking, and sit-to-stand. This programme was done for 60 mins, three times/week for four weeks.

Statistical Analysis

The data were computed and analysed using SPSS version 27. All the quantitative variables were tallied after checking for normal distribution within each group. Since the data did not follow normal distribution therefore Wilcoxon paired test was used for analysing the data (p value < 0.001).

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Result

Table 3 shows a statistically significant increase in the Berg Balance Scale score after the intervention. The Falls Efficacy score and TUG score before and after the intervention showed that there was a decrease in the scores after the intervention. The effect sizes (ranging from 0.86 to 0.89) indicate large effects for all three scales, suggesting substantial improvements in balance, efficacy, and mobility post-intervention. Figure 1 shows the comparison of pre- and post-scores.

Table 2.Otago Exercise Programme

Activities	Repetitions
Front knee strengthening exercise	2 sets, 10 repetitions
Back knee strengthening exercise	2 sets, 10 repetitions
Side hip strengthening exercise	2 sets, 10 repetitions
Calf raises	2 sets, 10 repetitions
Toe raises	2 sets, 10 repetitions
Knee bends	2 sets, 10 repetitions
Backwards walking	10 steps, 4 times
Walking and turning around	Make a figure of “8”, 2 times
Sideways walking	10 steps, 4 times
Tandem stance	10 seconds
Tandem walk	10 steps
One leg stand	10 seconds
Heel walking	10 steps, 4 times
Toe walking	10 steps, 4 times
Heel-toe walking backwards	10 steps, 4 times
Stand to sit	5 stands
Stair walking	5 steps up, 5 steps down

Table 3.Comparison of Berg Balance Scale, Falls Efficacy Scale and Timed Up and Go Test Scores Before and After Intervention

Scale/ Test	Post-Test, N = 32[1]	Pre-Test, N = 32[1]	p Value[2]	Effect Size
Berg Balance Scale	52 (49–55)	39 (31–43)	< 0.001	0.86
Falls Efficacy Scale	19 (10–28)	28 (10–46)	< 0.001	0.87
Timed Up and Go Test	13 (11–16)	16 (15–18)	< 0.001	0.89

[1]Median (Range)
[2]Wilcoxon paired test

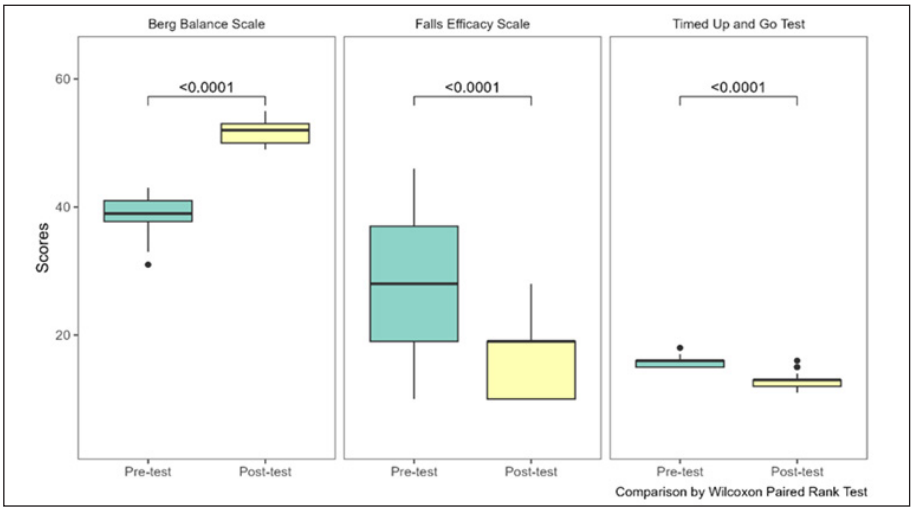

Figure 1.Comparison of Pre- and Post-BBS, FES & TUG Scores

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Discussion

Early DM symptoms include neuropathy, which steadily worsens over the years to cause systemic harm. There is a 49% probability of developing neuropathy if someone has diabetes for 25 years or more. The severity of neuropathy also rises with the length of time someone has had diabetes and poor glycaemic control. Studies suggest that neuropathy cases increase after 55 years of age.[18] The patients in this research varied from 40 to 70 years, with a mean age of 55.56 ± 9.43. Gender analysis of the participants revealed that the number of females (59.4%) were more than males (40.6%). Previous studies stated that males are more affected than females. Studies at the individual level showed that males had higher resistance and lower BMI than women which confirmed this epidemiological finding. This is largely because of their tendency to accumulate fat in the viscera and hepatic system.[19] Many daily activities, from simple ones like standing quietly to more challenging ones like walking while talking or changing directions, depend on balance.[20] Balance disorders represent a major concern among DN due to their association with falls. There is more postural sway in these individuals. Otago exercise is a well-known exercise programme for people with balance problems. This research used an experimental design to determine if OEP may help DN patients with balance and lower their chance of falling. All the subjects received OEP, 3 days a week, for four weeks and the session lasted for approximately 60 minutes. In this trial, balance among those with DN significantly improved. Otago training significantly increased the Berg Balance Scale score from a median of 39 (range 31–43) to 52 (range 49–55). This improvement can be a result of the participant's commitment. Patel et al. demonstrated that the Berg balance scale showed good test-retest reliability indicating that BBS could be utilised to evaluate balance in patients with DN.[21] Jernigan et al. demonstrated the highest sensitivity at 90% for BBS and TUG in assessing fall risk with DPN patients.[22] Christopher et al. stated that the TUG exhibited excellent reliability in individuals having Huntington's disease, cerebral palsy, multiple sclerosis, stroke, along with individuals having a spinal cord injury.[23] Timar et al., in 2016, conducted a study on 198 patients with type 2 diabetes mellitus with neuropathy where balance impairment and risk of falls were assessed using four validated and standardised tools: Berg Balance Scale (BBS), Timed-up and Go test (TUG), Single Leg Stand test (SLS) and Fall Efficacy Scale (FES-I). The study concluded that the presence of DN in patients with DM is associated with impaired balance and a consecutive increase in the risk of falls.[24] In the present study, the FES scores decreased from 28 (range 10–46) to 19 (range 10–28) before and after the intervention, which has a significant impact on reducing fall efficacy. This can be interpreted as an increase in confidence and a decrease in fall fear among the participants. The Timed Up and Go Test (TUG) is a measure of mobility and functional ability and this study found that the post-intervention score is much lower than the pre-intervention score, 16 (range 15–18) to 13 (range 11–16) which has a highly significant impact on shortening the time required to complete the test. The present investigation showed that OEP considerably decreased the study participants' chance of falling. This could be because OEP combines a walking programme, balance training, and muscular strengthening. Therefore, the analysis demonstrated that the OEP is a useful exercise prevention strategy for those with DN. Balance training was utilised to re-establish ankle stability, which might have helped the proprioceptive pathways that were damaged, leading to an improvement in balance and a reduction in sway parameters. The study findings, supported by the existing literature, suggest that OEP can improve body balance and muscle strength. According to a study by Kiik et al., 8 weeks of training intervention with a body balancing emphasis may lower the chance of falling among older adults in a community in Depok City, Indonesia.[25] The conclusion of this research is in accordance with their findings. Through this exercise, one may increase the body's flexibility, balance, and walking speed. Studies have shown that the OEP has improved patients' balance, lower limb strength, overall fitness level, and level of independence. The OEP needs relatively low supervision and material costs. Otago exercises mainly focus on the lower limbs, such as the hip, ankle and knee joint, and ankle cuff, weight bearing also improves the muscle strength of the knee extensors and flexors, back flexors, hip abductors, along with ankle plantar flexors. Son et al. demonstrated that Tai Chi & Otago exercises help in the improvement of the function of muscle fibres, boost myofibrillar protein production, and increase muscular strength.[26] According to Robertson et al., OEP has resulted in a decrease in falls and injuries connected to falls by 35% and is safe for people to do at home.[27] Thus, the current research offers probable evidence that OEP helps patients with DN improve their balance while also lowering their chance of falling.

Limitations of the Study

In this study, the lack of a control group limited the generalisation of the findings. The duration for which the patients were suffering from diabetic neuropathy was not considered. Also, there was no long-term follow-up done to check the efficacy of OEP.

Future Scope of the Study

Employing sophisticated analysis systems like Motor Nerve Conduction Studies, posturography using force plate systems, and pressure measurement platforms will further warrant the efficacy of Otago exercises. Further research can be conducted using the Otago Exercise Programme

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for other neurological conditions that affect balance and increase the risks of fall.

Conclusion

The study's results led researchers to the conclusion that the individuals with DN had improved functional mobility and balance after receiving OEP. In terms of functional mobility and balance, statistically significant improvements in TUG, BBS, and FES were found. In order to increase strength and balance, which eventually leads to the prevention of falls in DN, OEP may be utilised in daily clinical practice as well as a home exercise programme.

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Conflict of Interest: None

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