

Effectiveness of Balance Exercise on Balance, Functional Ambulation, and Fear of Falling in an Elderly Individual with Diabetic Neuropathy: - A Single-Case experimental Study

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ABSTRACT

Background: Diabetic neuropathy can impair sensory and motor function, resulting in reduced postural stability, impaired functional ambulation, and increased fear of falling. Balance exercises may improve postural control and functional mobility in individuals with diabetic neuropathy.

Objective: To determine the effect on balance, functional ambulation, and fear of falling in an elderly individual with diabetic neuropathy.

Case Presentation: A single elderly individual with Type II diabetes mellitus and clinically diagnosed diabetic neuropathy was selected based on predefined eligibility criteria. Baseline assessment was performed using the Berg Balance Scale (BBS), Timed Up and Go (TUG) test, and Fall Efficacy Scale (FES).

Intervention: The participant received a supervised balance exercises in addition to conventional exercises for four weeks. The balance exercises consisted of static and dynamic balance activities, including tandem standing, single-leg standing, toe standing, heel standing, toe walking, heel walking, tandem forward walking, and tandem backward walking. The exercises were performed once daily under therapist supervision.

Outcome: Post-intervention assessments were performed using the same outcome measures. Changes in BBS, TUG, and FES scores from baseline to post-intervention were evaluated descriptively to determine the response to the intervention.

Conclusion: The single-case intervention demonstrated the potential of a structured balance exercise programmed to improve balance and functional ambulation and reduce fear of falling in an elderly individual with diabetic neuropathy. Further studies involving larger samples and controlled designs are required to establish the effectiveness and generalizability of the intervention.

Keywords: Diabetic neuropathy, balance exercise, Berg Balance Scale, Timed Up and Go, fall efficacy, functional ambulation, single-case study.

1. Introduction

Diabetic peripheral neuropathy (DPN) is one of the most common complications of diabetes mellitus and is characterized by sensory and motor impairments that can adversely affect postural control, gait, mobility, and functional independence in older adults. Loss of plantar sensation, impaired proprioception, muscle weakness, and delayed postural responses associated with DPN can compromise balance and increase the risk of falls, while repeated instability may also contribute to fear of falling and reduced participation in daily activities. Evidence indicates that exercise-based rehabilitation can improve important falls-related outcomes in older adults with diabetes, including static balance, lower-limb strength, and gait performance¹.

In individuals with DPN, systematic reviews have further reported that gait, balance, and functional training can improve balance and reduce fear of falling, although the evidence for actual reduction in fall incidence remains limited².

More recent evidence suggests that balance exercise is particularly beneficial for older adults with DPN, with significant improvements reported in Timed Up and Go performance, gait speed, Berg Balance Scale scores, and single-leg standing ability³.

A 2024 randomized controlled trial also demonstrated that balance-based resistance exercise significantly improved balance and reduced fear of falling in older adults with DPN⁴.

1.2 Need of the study

The diabetic neuropathy in elderly people is at increased risk of impaired balance, reduced functional ambulation, and more over fear of falling, which can negatively affect independence and quality of life. Therefore, this single-case experimental study is needed to evaluate whether a structured balance exercise programme can effectively improve these clinically important outcomes.

1.3 Aim of the study

The aim of this study is to determine the effectiveness of balance exercise on balance, functional ambulation, and fear of falling in an elderly individual with diabetic neuropathy. The study also aims to assess the individual's response to a structured balance exercise programme using a single-case experimental design

1.4 Objective of the study

The objective of this study is to evaluate the effect of a structured balance exercise programme on balance, functional ambulation, and fear of falling in an elderly individual with diabetic neuropathy. It also aims to assess the changes in these outcomes before and after the intervention.

1.5 Hypothesis

1.5.1 Null hypothesis

There is no significant difference in Balance Exercise on Balance, Functional Ambulation, and Fear of Falling in an Elderly Individual with Diabetic Neuropathy

1.5.2 Alternate hypothesis

It is hypothesized that there is a significant difference in Balance Exercise on Balance, Functional Ambulation, and Fear of Falling in an Elderly Individual with Diabetic Neuropathy.

2. Materials and methods

2.1. Study design

A single case experimental study

2.2 study setting

The study was conducted at RVS physiotherapy OPD

2.3 Study duration

3 months

2.4 Case history

A 65-year-old male patient with a 26-year history of Type II Diabetes Mellitus presented with complaints of sensory disturbances in both feet, difficulty in walking, and recurrent episodes of falling. The patient reported that the sensory symptoms in the feet had been present for approximately 2 years and had progressively affected his ability to walk safely and efficiently. He experienced frequent falls, particularly during ambulation, suggesting impaired postural stability and functional mobility.

The patient had a longstanding history of Type II Diabetes Mellitus for approximately 26 years. The prolonged duration of diabetes was associated with the development of sensory impairment in the feet, consistent with features of diabetic peripheral neuropathy. The patient reported difficulty in walking properly and recurrent loss of balance. These difficulties had affected his functional ambulation and increased his risk of falls during daily activities.

There was no reported history of neurological disorders involving the brain or spinal cord. No other central neurological condition was reported that could account for the patient's balance and gait difficulties. The patient's family history was significant for diabetes mellitus, as both parents were diabetic, indicating a positive family history of the condition.

Based on the clinical history, the patient's long duration of diabetes, sensory impairment in the feet, impaired walking ability, and recurrent falls were considered relevant features for evaluating balance, functional ambulation, and fear of falling. The patient was therefore selected for assessment and intervention using standardized outcome measures, including the Berg Balance Scale (BBS), Timed Up and Go (TUG) test, and Fall Efficacy Scale (FES).

2.5 Subject description

The subject was a 65-year-old male with a 26-year history of Type II Diabetes Mellitus and a 2-year history of sensory impairment in the feet. He presented with difficulty in walking and recurrent episodes of falling, indicating impaired functional mobility and balance. There was no reported history of brain or spinal cord disorders. Nerve conduction study findings supported the presence of peripheral nerve involvement consistent with diabetic neuropathy. The subject was selected to evaluate the effect of a structured balance exercise programme on balance, functional ambulation, and fear of falling.

2.6 outcome measures

1. Berg Balance Scale (BBS): Used to assess the subject's functional balance and postural stability during various static and dynamic activities. Higher scores indicate better balance performance.
2. Timed Up and Go (TUG) Test: Used to assess functional mobility, walking ability, and risk of falling. The time taken by the subject to stand from a chair, walk 3 metres, turn, return, and sit down was recorded.
3. Falls Efficacy Scale (FES): Used to assess the subject's level of concern or fear of falling while performing common activities of daily living.

2.7 Operational tools

- Armless chair – for TUG test and balance exercises.
- Measuring tape – to mark the 3-metre walking distance for the TUG test.
- Stopwatch – to record TUG performance time.
- Straight-line/tape marking – for tandem walking and heel/toe walking.
- Stable support/parallel bars– for safety during standing balance exercises.
- Exercise mat – for selected balance exercises.
- Footwear – standardized comfortable footwear, if used during testing.

- Assessment forms/data sheets – for recording BBS, TUG, and FES scores

2.8 Procedure

The consent taken from the patient. The subject was first assessed at baseline using the Berg Balance Scale (BBS), Timed Up and Go (TUG) test, and Falls Efficacy Scale (FES). Following the baseline assessment, a supervised balance exercise programme was administered for 3 months, once daily, in addition to conventional exercises.

2.9 Treatment Procedure

The subject underwent a 3 months supervised balance exercise programme in addition to conventional exercises, with the sessions conducted once daily under the supervision of a physiotherapist. The programme included static and dynamic balance activities. Exercises were initially performed with appropriate support to ensure safety and were progressed according to the subject's tolerance and ability. Adequate rest periods were provided between exercises, and close supervision was maintained throughout the sessions because of the subject's history of recurrent falls. The patient was assessed and the exercise programme was progressed systematically for every 4 weeks over a three-month period, after which post-intervention assessment was performed using the Berg Balance Scale, Timed Up and Go test, and Falls Efficacy Scale.

2.10 Intervention protocol

The subject performed the balance exercise programme once daily for four consecutive weeks under physiotherapist supervision. Each session began with a 5-minutes sensory re-education to stimulate the sensory nerves of plantar aspect of foot, 5- minutes warm-up and end with 5-minutes cool down. The exercise progresses every month

2.10.1 Balance exercises

The rehabilitation program consisted of;

Static exercises

- tandem standing
- single-leg standing
- toe standing
- heel standing
- standing balancing on foam pad

Dynamic exercises

- toe walking
- heel walking
- tandem forward walking
- tandem backward walking
- Frenkel's exercise
- Forward stepping
- Side stepping

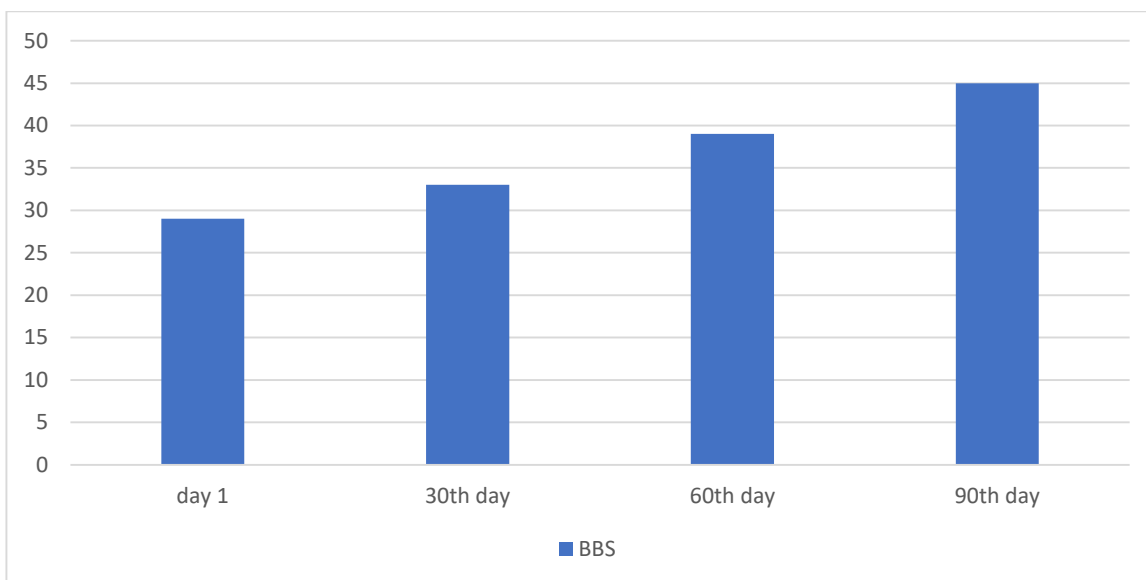
365. Results

3.1 Patient characteristics

S.No	variable	value
1	Age	65 years
2	Gender	male
3	Height	168 cm
4	Weight	85 kg
5	BMI	30.1 KG/M ²

3.2 Berg Balance Scale (BBS)

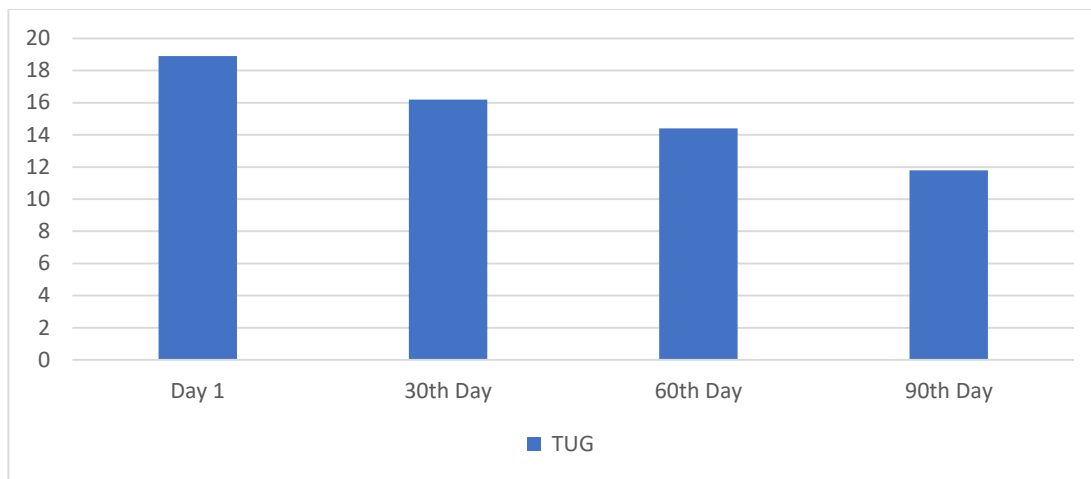
S.No	Assessment period	BBS Score
1	1 st Day	29/56
2	30 th Day	33/56
3	60 th Day	39/56
4	90 th Day	45/56



Graph 1-BBS

3.3 Timed Up and Go Test (TUG)

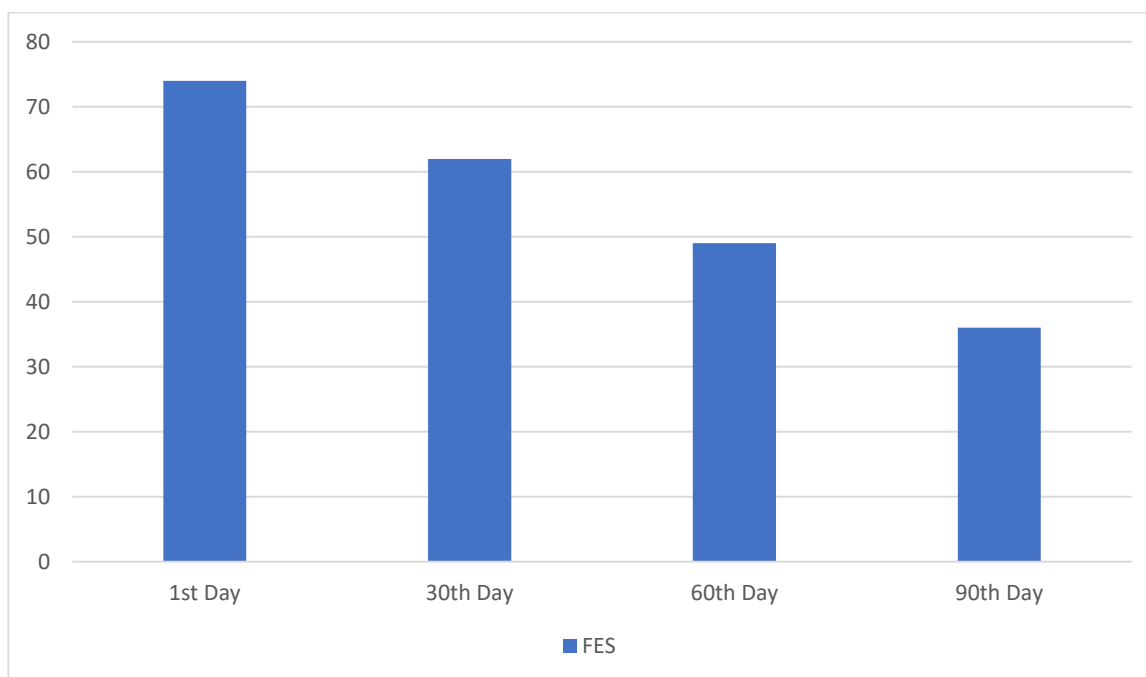
S.No	Assessment period	TUG score
1	1 st Day	18.9 sec
2	30 th Day	16.2 sec
3	60 th Day	14.4 sec
4	90 th Day	11.8 sec



Graph 2- TUG

3.4 Falls Efficacy Scale

S.No	Assessment period	FES score
1	1 st Day	74/100
2	30 th Day	62/100
3	60 th Day	49/100
4	90 th Day	36/100



Graph 3 -FES

3.4 Discussion

The present single-case experimental study was conducted to determine the effect of a structured balance exercise programme on balance, functional ambulation, and fear of falling in a 65-year-old male with long-standing Type II diabetes mellitus and diabetic peripheral neuropathy. The subject had a 26-year history of diabetes and approximately 2 years of sensory impairment in the feet, accompanied by difficulty in walking

and recurrent falls. These problems may be attributed to impaired peripheral sensory input associated with diabetic neuropathy, which can negatively affect postural control, gait, and functional mobility.

The study showed improvement in balance, functional mobility, and fear of falling following a 3-month structured balance exercise programme in an elderly individual with diabetic neuropathy. The BBS score improved from 29/56 to 45/56, while TUG time decreased from 18.9 to 11.8 seconds, indicating improved balance and functional ambulation. The FES score decreased from 74/100 to 36/100, suggesting reduced fear of falling and improved confidence during daily activities. These findings indicate that structured balance exercises may be beneficial in improving functional performance and reducing fall-related concerns in individuals with diabetic neuropathy.

4 Conclusion

The study concluded that a 3-month structured balance exercise programme combined with sensory re-education may improve balance and functional ambulation and reduce fear of falling in an elderly individual with diabetic neuropathy. The improvement in BBS, TUG, and FES scores suggests that combining balance training with sensory re-education may be beneficial in improving postural control, functional mobility, and confidence during daily activities. Further studies with larger samples and controlled designs are recommended.

Limitations

1. The study included only one participant
2. The study had a relatively short duration of 3 months
3. No long-term follow-up.
4. Potential factors such as daily physical activity, diabetic control, and medication may have influenced the outcomes.

Recommendations

1. Future studies should include larger sample sizes.
2. Long term follow-up studies are recommended.
3. Future studies should compare balance exercise alone, sensory re-education alone, and combined intervention.
4. Longer interventions should be included to determine the long-term effects.

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References

1. Exercise interventions for the improvement of falls-related outcomes among older adults with diabetes mellitus: A systematic review and meta-analyses
2. Efficacy of exercise on balance, fear of falling, and risk of falls in patients with diabetic peripheral neuropathy: a systematic review and meta-analysis
3. Effectiveness of various exercise types in reducing fall risk among older adults with diabetic peripheral neuropathy: A systematic review and meta-analysis
4. The Effect of Resistance Exercises Using an Elastic Band on Balance and Fear of Falling in Older Adults With Diabetic Peripheral Neuropathy: A 16-week Randomized Controlled Trial
5. Berg K, Wood-Dauphinee S, Williams JI, Maki B. Measuring balance in the elderly: validation of an instrument. Canadian Journal of Public Health. 1992;83(Suppl 2):S7-S11.

6. Mathias S, Nayak USL, Isaacs B. Balance in elderly patients: the “Get-Up and Go” test. Archives of Physical Medicine and Rehabilitation. 1986;67(6):387-389.
7. Tinetti ME, Richman D, Powell L. Falls efficacy as a measure of fear of falling. Journal of Gerontology. 1990;45(6):P239-P243. doi:10.1093/geronj/45.6.P239.

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