EFFECT OF VESTIBULAR BASED BALANCE TRAINING AMONG DIABETIC NEUROPATHY PATIENT

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Abstract:

Background: Diabetic neuropathy (DN), a prevalent complication of diabetes, affects approximately 20% of diabetic patients, leading to significant impairments in balance and increased fall risks. Current therapeutic interventions, including conventional occupational therapy, provide partial relief. However, vestibular-based balance training (VBBT) offers a novel approach to improving postural stability and functional outcomes in DN patients. To assess the efficacy of VBBT in enhancing balance performance among diabetic neuropathy patients, thereby reducing the risk of falls and improving quality of life. **Methods:** This quasi-experimental study recruited 30 participants with diabetic neuropathy (15 in the experimental group, 15 in the control group) from Chennai-based healthcare centers. Participants underwent screening using the Michigan Neuropathy Screening Instrument (MNSI) and baseline balance evaluation using the Berg Balance Scale (BBS). The experimental group received VBBT involving progressive exercises such as tandem walking and single-leg stance, while the control group underwent conventional occupational therapy. Both interventions were conducted thrice weekly for 12 weeks, followed by post-intervention balance assessment. **Results:** Both groups demonstrated significant improvement in BBS scores. The control group showed a mean improvement from 36 ± 3.46 to 39.8 ± 3.84 (p = 0.001), while the experimental group improved from 34.2 ± 5.61 to 44.27 ± 3.35 (p = 0.001). Intergroup analysis revealed superior outcomes in the experimental group (p = 0.006), confirming the effectiveness of VBBT. **Conclusion:** VBBT significantly enhances balance performance in diabetic neuropathy patients compared to conventional therapy. These findings underscore the potential of incorporating VBBT into standard therapeutic protocols to address balance deficits and fall risks in this population. Future studies should explore the long-term benefits and broader applicability of VBBT in diverse clinical settings.

Key words: Diabetic Neuropathy, Vestibular-Based Balance Training, Balance Performance, Fall Risk, Occupational Therapy

Introduction:

Diabetes is a rapidly growing global health concern, with India being home to the second-largest diabetic population. As of 2021, India had approximately 74.9 million individuals living with diabetes, a figure projected to rise to 124.9 million by 2045. Globally, the prevalence of diabetes was 537 million in 2021, with a predicted increase to 643 million by 2030 if preventative measures are not implemented (1). Diabetes Mellitus (DM) is a metabolic disorder marked by chronic hyperglycemia resulting from insulin resistance or insufficient insulin production. The persistent hyperglycemia associated with DM can lead to various

complications, including cardiovascular disease, which is responsible for up to 70% of deaths among diabetic patients (2,3).

One of the most prevalent complications of diabetes is diabetic neuropathy (DN), which affects approximately 20% of diabetic individuals. DN is associated with acute and chronic complications that significantly impair quality of life and hinder self-management of diabetes (4,5). Clinical manifestations of diabetes include polyuria, polydipsia, polyphagia, and weight loss, whereas diabetic neuropathy commonly presents with pain in the extremities, sleep disturbances, and autonomic dysfunctions such as gastrointestinal and cardiovascular irregularities (6).

Diabetes can be classified into several types, including Type 1 diabetes, an autoimmune condition causing irreversible pancreatic beta-cell damage, and Type 2 diabetes, characterized by insulin resistance and a progressive decline in insulin production (7). Neuropathy associated with diabetes manifests in various forms, such as mononeuropathy, polyneuropathy, autonomic neuropathy, and proximal neuropathy, which affect sensory, motor, and autonomic nerve functions (8).

The development of diabetic neuropathy is influenced by risk factors such as prolonged hyperglycemia, obesity, dyslipidemia, hypertension, smoking, and alcohol consumption. Obesity and cardiovascular comorbidities further exacerbate the severity of neuropathy (9). Management strategies for diabetic neuropathy aim to slow disease progression through glycemic control, physical activity, and weight management while addressing pain relief with medications like pregabalin, gabapentin, and duloxetine (10).

Occupational therapy (OT) is pivotal in diabetes care, focusing on promoting self-management, emotional well-being, and functional independence. Interventions like the REAL Diabetes program are tailored to individual needs and emphasize self-management strategies. For patients with diabetic neuropathy, balance training is particularly significant in preventing falls and improving overall stability (11,12). Despite these advancements, balance deficits in patients with diabetic neuropathy underline the need for further research into vestibular-based balance training as an intervention to enhance postural stability and reduce fall risks (9).

The aim of this study is to explore the role of vestibular-based balance training as a therapeutic intervention for individuals with diabetic neuropathy. The study seeks to evaluate the potential of such training in improving postural stability and reducing the risk of falls, thereby enhancing quality of life. The objectives include assessing the prevalence of balance deficits in patients with diabetic neuropathy, understanding the relationship between vestibular dysfunction and postural instability, and developing evidence-based strategies to address these challenges.

Methodology:

Research Design

A quasi-experimental research design was employed to evaluate the effectiveness of vestibular-based balance training on improving balance performance in diabetic neuropathy patients.

Sampling Technique

Convenience sampling was used to recruit participants.

Sample Size

The study included a total of 30 participants, with 15 in the experimental group and 15 in the control group.

Sample Setting

Participants were selected from Gremaltes Hospital and Aruna Diabetic Centre, Chennai, based on the inclusion and exclusion criteria.

Variables

- **Independent Variable:** Vestibular-based Balance Training
- **Dependent Variable:** Balance performance

Selection Criteria

Inclusion Criteria:

- Age: 50 to 70 years.
- Individuals of both genders.
- Diagnosed diabetic patients.
- Diabetic individuals exhibiting neuropathic symptoms.

Exclusion Criteria:

- Individuals with cognitive dysfunction.
- Individuals with balance impairment due to other neurological conditions.

Scales Used

Screening Tool: Michigan Neuropathy Screening Instrument (MNSI)

- **Description:** A validated tool for diagnosing and quantifying diabetic distal symmetrical peripheral neuropathy.
- **Components:** A 15-item self-administered questionnaire and a lower extremity examination.
- **Interpretation:** A score of ≥7 (questionnaire) or ≥2.5 (clinical examination) indicates diabetic neuropathy.

Scale Used: Berg Balance Scale (BBS)

- **Description:** A 14-item scale assessing static and dynamic balance through tasks like postural changes, transfers, and object retrieval.
- **Scoring:** 0 (low function) to 4 (high function) per task; total score = 56.
- **Interpretation:**
    - 0–20: High fall risk
    - 21–40: Medium fall risk
    - 41–56: Low fall risk

Data Collection Procedure

Informed consent was obtained from all participants and the concerned centers. The procedure was explained, and those willing to participate were screened using the MNSI to identify patients with diabetic neuropathy. Thirty participants were selected based on the selection criteria. Pretest measurements were taken using the Berg Balance Scale.

Participants were randomly assigned to either the experimental group (functional task training) or the control group (conventional occupational therapy) for a duration of 12 weeks (36 sessions). Each session lasted for 40 minutes, with a 10-minute demonstration and 30 minutes

of active training. Posttest measurements were conducted at the end of the study to assess the outcomes.

Intervention Protocol

Duration and Frequency:

- **Study Duration:** 12 weeks.
- **Session Frequency:** 3 days per week.
- **Session Duration:** 40 minutes.

Experimental Group Activities:

Participants in the experimental group underwent vestibular-based balance training, including tasks such as forward reach, single-leg stance, tandem walking, and functional training. Activities progressed in difficulty across 36 sessions.

Control Group Activities:

Conventional occupational therapy was provided for the same duration.

Results:

This study employed a quantitative approach with inferential statistical methods to analyze the data. The Wilcoxon signed-rank test was used to compare pretest and posttest scores within groups, while the Mann-Whitney U test was used to assess differences between the experimental and control groups. Data were analyzed using IBM SPSS version 23, with a significance level set at P=0.05P = 0.05P=0.05.

In the control group, the mean pretest score was 36 ± 3.4641, and the mean posttest score was 39.8 ± 3.83964. The Wilcoxon signed-rank test yielded a ZZZ-value of -3.447 with a PPP-value of 0.001, indicating a statistically significant improvement in balance performance after the intervention.

Table 1: Pretest and Posttest Scores in the Control Group

Test	Mean	SD	N	ZZZ-value	PPP-value
Cntr_Pre	36	3.4641	15	-3.447	0.001*
Cntr_Post	39.8	3.83964	15		

*Significant at 5% alpha level

In the experimental group, the mean pretest score was 34.2 ± 5.60867, and the mean posttest score was 44.27 ± 3.34806. The Wilcoxon signed-rank test yielded a ZZZ-value of -3.416 with a PPP-value of 0.001, indicating a statistically significant improvement in balance performance after the intervention.

Table 2: Pretest and Posttest Scores in the Experimental Group

Test	Mean	SD	N	ZZZ-value	PPP-value
Expt_Pre	34.2	5.60867	15	-3.416	0.001*
Expt_Post	44.27	3.34806	15		

*Significant at 5% alpha level

The Mann-Whitney U test was used to compare posttest scores between the control and experimental groups. The mean posttest score in the control group was 39.8 ± 3.83964, while

it was 44.27 ± 3.34806 in the experimental group. The test yielded a ZZZ-value of -2.696 with a PPP-value of 0.006, indicating a statistically significant difference between the two groups.

Table 3: Post test Scores of the Control and Experimental Groups

Group	Mean	SD	N	ZZZ-value	PPP-value
Cntr_Post	39.8	3.83964	15	-2.696	0.006*
Expt_Post	44.27	3.34806	15		

*Significant at 5% alpha level

The results demonstrate that while both groups showed significant improvements in balance performance, the experimental group receiving vestibular-based balance training exhibited greater improvements compared to the control group.

Discussion:

This study aimed to investigate the effects of Vestibular-Based Balance Training (VBBT) on balance performance among diabetic neuropathy patients. Conducted over three months with participants from Aruna Diabetic Centre and Gremaltes Hospital, Chennai, the research adopted a rigorous design, assessing neuropathy symptoms using the Michigan Neuropathy Screening Instrument (MNSI) and balance skills using the Berg Balance Scale (BBS). Thirty participants were equally divided into experimental and control groups, with the former receiving VBBT in addition to conventional occupational therapy, and the latter receiving only conventional therapy (13). Control Group Improvement Statistical analysis of the control group's pretest and posttest BBS scores revealed a significant improvement. The mean score increased from 36 to 39.8, with a p-value of 0.001 (Table 1). This suggests that even conventional therapy has a positive impact on balance performance in diabetic neuropathy patients, corroborating findings from prior studies. Experimental Group Improvement In contrast, the experimental group exhibited a more pronounced improvement in balance. The mean BBS score rose from 34.2 (SD = 5.60867) in the pretest to 44.27 (SD = 3.34806) in the posttest, with a p-value of 0.001 (Table 2). This statistically significant difference underscores the efficacy of VBBT, highlighting its ability to enhance balance control beyond the effects of conventional therapy. Comparison Between Groups Posttest analysis between the experimental and control groups further validated the superiority of VBBT. The experimental group achieved a mean score of 44.27 compared to 39.8 in the control group, with a p-value of 0.006 (Table 3). This finding indicates that the experimental intervention led to substantially greater improvements in balance.

The results align with previous research, such as that by Shukla et al.,(14) which emphasizes the benefits of targeted vestibular interventions in improving motor and balance skills among diabetic neuropathy patients. VBBT likely enhances proprioception, coordination, and motor control through activities such as weight shifting and proprioceptive training, facilitating neuroplasticity and motor learning. The observed improvements in the experimental group substantiate the hypothesis that vestibular-based interventions provide a robust framework for addressing balance deficits in this population (15).

This study highlights the potential of incorporating VBBT into routine therapeutic protocols for diabetic neuropathy patients. The significant improvements observed in the experimental

group underscore the need for healthcare practitioners to adopt specialized training programs to optimize patient outcomes. Future research could explore long-term effects and scalability of such interventions across diverse clinical settings.

Conclusion:

This three-month study evaluated the impact of Vestibular-Based Balance Training (VBBT) on diabetic neuropathy patients. Using the Berg Balance Scale, balance performance was assessed in 30 participants divided into experimental and control groups. Key findings include:

- Significant improvement in balance in both groups, with the experimental group showing higher improvement (P = 0.001) compared to the control group (P = 0.001).
- Posttest comparisons revealed a statistically significant difference between the groups (P = 0.006), confirming the efficacy of VBBT.

These results demonstrate the effectiveness of vestibular-based interventions in enhancing balance among diabetic neuropathy patients. VBBT is a valuable addition to conventional therapy, offering targeted improvements in balance performance. Future studies should investigate its broader applicability and long-term benefits.

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