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Effect of Buerger Allen exercise in alleviating peripheral neuropathy symptoms among patients with type 2 diabetes mellitus: A randomized controlled repeated-measures trial

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Abstract:
Diabetic peripheral neuropathy (DPN) is a common complication of Type 2 diabetes mellitus (T2DM) that causes pain, sensory loss and functional impairments. Therefore, it is of interest to evaluate the effectiveness of Buerger Allen Exercise (BAE) in alleviating peripheral neuropathy symptoms in T2DM patients. A pre- and post-test design with control and experimental groups was used, with the experimental group performing BAE for 15 days. Significant reductions in neuropathy symptoms were observed in the experimental group compared to the control group. Thus, data show the potential of Buerger Allen Exercise as a simple and cost-effective intervention for improving peripheral circulation and functional outcomes in diabetic neuropathy.

Keywords: Type 2 diabetes mellitus (T2DM), diabetic peripheral neuropathy (DPN), Buerger Allen exercise (BAE), lower extremity circulation, diabetic foot, exercise therapy, nursing intervention

Background:
Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin action, or both **[1]**. The global prevalence of diabetes continues to rise at an alarming rate, making it one of the major public health concerns worldwide **[2]**. Type 2 diabetes mellitus accounts for nearly 90–95% of all diabetes cases and is strongly associated with obesity, sedentary lifestyle, aging and genetic predisposition **[3]**. Long-standing hyperglycemia contributes to microvascular and macrovascular complications affecting multiple organ systems. Among these complications, diabetic peripheral neuropathy (DPN) is one of the most common and debilitating conditions **[4]**. DPN results from chronic metabolic and vascular alterations that damage peripheral nerves, particularly in the lower extremities **[5]**. Diabetic peripheral neuropathy is characterized by numbness, tingling sensation, burning pain, paresthesia, muscle weakness, diminished reflexes and sensory loss **[6]**. Progressive nerve degeneration impairs balance, gait, proprioception and functional mobility **[6]**. Patients with DPN are at high risk for foot deformities, pressure ulcers, infections and amputations. These complications substantially reduce quality of life and increase healthcare expenditure **[7]**. The pathophysiology of diabetic neuropathy is multifactorial and involves oxidative stress, microvascular insufficiency, advanced glycation end-product formation, mitochondrial dysfunction, inflammation and impaired nerve conduction **[8]**. Chronic ischemia and reduced peripheral blood supply play a crucial role in the progression of neuropathy**.** Although pharmacological management provides symptomatic relief; many medications are associated with adverse effects and do not adequately reverse nerve damage. Therefore, non-pharmacological interventions that improve peripheral circulation and nerve function have gained increasing attention **[9, 10]**. Buerger Allen Exercise is a postural exercise designed to improve lower extremity circulation through alternating gravitational changes. The exercise involves elevation, dependency and horizontal positioning of the legs to enhance arterial perfusion and venous return. It is simple, low-cost, safe and suitable for home-based practice **[11]**. Therefore it is of interest to evaluate the effectiveness of Buerger Allen Exercise in reducing peripheral neuropathy symptoms among patients with Type 2 diabetes mellitus admitted to a selected hospital in Coimbatore.

Methodology:
The present study adopted a quantitative evaluative research approach to determine the effectiveness of Buerger Allen Exercise on peripheral neuropathy symptoms among patients with Type 2 diabetes mellitus. The quantitative approach was considered appropriate because the study aimed to obtain measurable and objective data regarding changes in peripheral neuropathy symptoms before and after administration of the intervention. This approach enabled the investigator to systematically compare the outcomes between the experimental and control groups using statistical methods. Quantitative research also facilitated accurate measurement of symptom reduction and helped establish the scientific effectiveness of the intervention through statistical analysis.

Research design:
A true experimental pre- and post-test repeated-measures control group design was adopted for the study. This design was selected because it is considered one of the most rigorous methods for evaluating the effectiveness of interventions. The design incorporated the essential characteristics of experimentation, including manipulation, control and randomization. The study participants were randomly assigned to either the experimental group or the control group. Baseline assessment of peripheral neuropathy symptoms was conducted for both groups before the intervention. The experimental group

received Buerger Allen Exercise in addition to routine hospital care, whereas the control group received only routine care. Repeated post-test assessments were conducted on the 5th, 10th and 15th days to evaluate changes in peripheral neuropathy symptoms over time and determine the sustained effect of the intervention.

Setting of the study:
The study was conducted in the general medical wards of a selected hospital in Coimbatore District, Tamil Nadu. The selected hospital provides comprehensive care for patients with diabetes mellitus and its associated complications. The setting was considered appropriate for the study because a sufficient number of patients with Type 2 diabetes mellitus were admitted regularly, which facilitated adequate, sample recruitment and repeated observation. The hospital setting also provided a controlled environment for implementing the intervention and monitoring participants throughout the study period.

Population:
The target population of the study consisted of patients diagnosed with Type 2 diabetes mellitus. The accessible population included patients with peripheral neuropathy symptoms who were admitted to the selected hospital during the period of data collection and fulfilled the inclusion criteria. These patients were considered appropriate for the study because diabetic peripheral neuropathy is a common complication among individuals with prolonged diabetes mellitus and poor glycemic control.

Sample:
The sample for the present study consisted of 100 patients diagnosed with Type 2 diabetes mellitus who fulfilled the eligibility criteria. The selected participants were admitted to the medical wards of the selected hospital during the data collection period. The participants were divided equally into experimental and control groups, with 50 participants in each group. The selected sample represented patients experiencing varying levels of peripheral neuropathy symptoms associated with diabetes mellitus.

Sampling technique:
Probability systematic random sampling technique was used to select the study participants. The sampling technique ensured equal opportunity for eligible participants to be included in the study and minimized selection bias. Every k^{th} eligible patient admitted to the medical ward during the data collection period was selected for participation. After selection, participants were randomly allocated into experimental and control groups. The use of probability sampling enhanced the representativeness and reliability of the study findings.

Inclusion criteria:
The study included patients aged between 40 and 60 years who were diagnosed with Type 2 diabetes mellitus and had HbA1c levels greater than 7%, indicating poor glycemic control. Patients who were physically able to participate in the exercise intervention and willing to provide informed consent were included in the study. Participants who were available during the entire period of data collection and capable of understanding instructions were also considered eligible for participation.

Exclusion criteria:
Patients with active foot ulcers, gangrene, severe lower limb complications, or severe mobility limitations were excluded from the study. Critically ill patients, disoriented individuals and patients unable to perform the prescribed exercises were also excluded. These exclusion criteria were adopted to ensure participant safety and maintain uniformity in the study sample.

Description of the tool:
The data collection instrument consisted of three sections developed to obtain comprehensive information regarding the participants and their peripheral neuropathy symptoms. Section A included demographic variables such as age, gender, education, occupation, marital status, annual income, type of family and type of house. These variables helped describe the socio-demographic characteristics of the participants. Section B included clinical variables such as duration of diabetes mellitus, dietary pattern, hypertension and anemia, body mass index, treatment modality, HbA1c values and random blood sugar levels. These variables provided important clinical information related to diabetic status and associated health conditions. Section C consisted of the Diabetic Foot Peripheral Neuropathy Assessment Tool, which was used to assess peripheral neuropathy symptoms among the participants. The tool included assessment of pain, monofilament sensation, touch sensation, proprioception, temperature perception, vibration sensation, Achilles reflex, sensory symptoms, single-leg balance, range of motion, foot muscle strength and foot deformity. The tool enabled comprehensive evaluation of sensory and motor neuropathy manifestations in the lower extremities.

Description of intervention:
The intervention used in the study was Buerger Allen Exercise, a structured therapeutic exercise designed to improve lower extremity circulation and reduce peripheral neuropathy symptoms. The exercise consisted of three sequential phases. In the first phase, the lower extremities were elevated to approximately 45–90 degrees for about four minutes until blanching of the skin occurred. This phase facilitated venous drainage and reduced venous congestion. During the second phase, the legs were lowered below body level until redness appeared. Participants were instructed to perform ankle and toe movements such as dorsiflexion, plantar flexion, inversion and eversion and toe flexion during this period. These movements stimulated muscle pump activity and enhanced peripheral circulation. In the third phase, the legs were placed horizontally on the bed for approximately seven minutes to stabilize circulation and facilitate vascular equilibration. The entire intervention was administered three times daily at six-hour intervals for a period of 15 consecutive days under supervision.

Validity and reliability:
Content validity of the tool and intervention was established through consultation with experts from the fields of nursing, medicine, surgery, physiotherapy, statistics and language departments. The experts reviewed the relevance, clarity, adequacy and appropriateness of the tool and intervention protocol. Necessary modifications suggested by the experts were incorporated before finalization. Reliability of the diabetic foot peripheral neuropathy assessment tool was established using the test–retest method. The findings indicated satisfactory consistency and stability of the instrument, confirming that the tool was reliable for use in the study.

Ethical considerations:
Ethical approval for the study was obtained from the Institutional Ethics Committee before commencement of data collection. Administrative permission was obtained from the authorities of the selected hospital. The purpose and procedure of the study were explained clearly too all participants and written informed consent was obtained prior to enrollment. Participants were assured that confidentiality and anonymity would be maintained throughout the study. They were informed that participation was voluntary and that they had the right to withdraw from the study at any stage without affecting their treatment or care. All ethical principles related to human participant research were strictly followed during the study.

Data collection procedure:
Data collection was carried out after obtaining ethical clearance and administrative permission from the hospital authorities. Participants who fulfilled the inclusion criteria were selected using systematic random sampling technique. After obtaining informed consent, baseline assessment of peripheral neuropathy symptoms was conducted for both experimental and control groups using the diabetic foot peripheral neuropathy assessment tool. The experimental group received Buerger Allen Exercise along with routine hospital care, whereas the control group received routine hospital care alone. The intervention was administered three times daily at six-hour intervals for 15 consecutive days. Repeated post-test assessments were conducted on the 5^{th}, 10^{th} and 15^{th} days using the same assessment tool to evaluate changes in peripheral neuropathy symptoms over time.

Data analysis:
The collected data were organized, coded, tabulated and analyzed using descriptive and inferential statistical methods. Descriptive statistics such as frequency, percentage, mean and standard deviation were used to summarize demographic variables, clinical variables and peripheral neuropathy symptom scores. Inferential statistics including independent t-test, paired t-test, repeated-measures ANOVA, Bonferroni post-hoc analysis and Chi-square test were used to determine the effectiveness of the intervention and identify associations between variables. Independent t-test was used to compare differences between experimental and control groups, while paired t-test was used to compare pre-test and post-test scores within groups. Repeated-measures ANOVA were applied to analyze repeated observations over time. Chi-square test was used to determine associations between peripheral neuropathy symptoms and selected demographic and clinical variables. Statistical significance was set at $p < 0.05$.

Results:
The results are presented under the following headings, based on data obtained from 100 participants (experimental group n = 50; control group n = 50). All 100 participants completed the study and there was no attrition. The demographic analysis showed that the largest proportion of participants in both groups belonged to the 56–60 year age group, accounting for 44% of the experimental group and 38% of the control group. Male participants predominated in groups, comprising 76% of the experimental group and 70% of the control group. Secondary education was the most common educational level in both groups and the majority of participants in both groups belonged to nuclear families (78% and 76% respectively). Nearly half of the participants in each group reported an annual income of 2–4 lakhs. The two groups were comparable with respect to all demographic variables, indicating that randomization was effective **(Table 1)**. Analysis of the clinical profile indicated that the majority of participants in both groups had a duration of diabetes mellitus exceeding five years, with 36% of the experimental group and 34% of the control group having had diabetes for more than eight years. A non-vegetarian dietary pattern was reported by 78% of the experimental group and 74% of the control group and most participants were engaged in moderate physical activity. Hypertension was present in 52% of the experimental group and 46% of the control group and mild anemia was the most frequent haematological finding. More than half of the participants in each group were overweight and elevated HbA1c values above 8% were recorded in 70% of the experimental group and 64% of the control group, indicating poor glycemic control and an increased risk of diabetic complications **(Table 2)**. Comparison of mean peripheral neuropathy scores of the right leg showed no statistically significant difference between the experimental and control groups during the pre-test assessment ($t = 1.36$, $p = 0.176$), confirming baseline comparability. Statistically significant differences were observed at all three post-test assessments. The mean neuropathy score of the experimental group declined progressively from 15.68 ± 5.12 at pre-test to 3.94 ± 3.04 at post-test III, representing a mean reduction of 11.74 points. The control group showed only a marginal change over the same period, from 16.92 ± 3.94 to 16.72 ± 3.55 **(Table 3)**. Analysis of the left leg scores followed the same pattern. No significant difference was present between the groups at baseline ($t = 0.60$, $p = 0.549$). The mean score of the experimental group decreased from 20.42 ± 5.86 at pre-test to 7.48 ± 3.72 at post-test III, a mean reduction of 12.94 points, whereas the control group demonstrated negligible improvement across the study period **(Table 4)**. Repeated-measures ANOVA revealed a statistically significant reduction in peripheral neuropathy scores across the

four assessment points in the experimental group for both lower extremities. For the right leg the obtained F value was 412.36 ($p < 0.001$) and for the left leg it was 536.84 ($p < 0.001$), indicating a highly significant improvement following the intervention. The control group did not demonstrate any statistically significant change across the repeated assessments for either extremity **(Table 5)**. Pairwise comparison using the paired t-test showed statistically significant differences between the pre-test score and each of the three post-test scores in the experimental group for both lower extremities, with the magnitude of improvement increasing progressively from post-test I to post-test III **(Table 6)**. Bonferroni post-hoc analysis confirmed that all pairwise differences between assessment points in the experimental group were statistically significant at the adjusted level of $p < 0.008$, indicating a continuous and cumulative reduction in neuropathic symptoms over the 15-day intervention period. For comparison, the corresponding within-group changes in the control group were minimal and statistically non-significant **(Table 7)**. Chi-square analysis revealed a statistically significant association between the level of peripheral neuropathy symptoms and type of family ($\chi^2 = 6.84$, $p = 0.033$) and duration of diabetes mellitus ($\chi^2 = 11.42$, $p = 0.022$). No statistically significant association was identified between the level of peripheral neuropathy symptoms and the remaining demographic and clinical variables **(Table 8)**. The findings showed that Buerger Allen Exercise, administered three times daily for 15 consecutive days, produced a statistically significant and progressive reduction in peripheral neuropathy symptoms in both lower extremities among patients with Type 2 diabetes mellitus. The experimental and control groups were comparable at baseline and the observed improvement was confined to the group receiving the intervention. The level of peripheral neuropathy symptoms was significantly associated with type of family and duration of diabetes mellitus. The research hypothesis stating that there is a significant difference in peripheral neuropathy symptom scores between patients who receive Buerger Allen Exercise and those who receive routine care alone was therefore accepted.

Table 1: Frequency and percentage distribution of demographic variables among the experimental and control groups (N = 100)

Demographic variable	Category	Experimental group (n = 50) n (%)	Control group (n = 50) n (%)
Age (years)	40–45	6 (12)	7 (14)
	46–50	10 (20)	11 (22)
	51–55	12 (24)	13 (26)
	56–60	22 (44)	19 (38)
Gender	Male	38 (76)	35 (70)
	Female	12 (24)	15 (30)
Education	No formal education	5 (10)	7 (14)
	Primary	13 (26)	16 (32)
	Secondary	24 (48)	20 (40)
	Graduate and above	8 (16)	7 (14)
Occupation	Unemployed	8 (16)	9 (18)
	Daily wage labourer	15 (30)	14 (28)
	Private employee	17 (34)	16 (32)
	Government employee	10 (20)	11 (22)
Marital status	Married	44 (88)	43 (86)
	Unmarried	2 (4)	3 (6)
	Widow / widower	4 (8)	4 (8)
Annual income	Less than 2 lakhs	14 (28)	16 (32)
	2–4 lakhs	23 (46)	21 (42)
	More than 4 lakhs	13 (26)	13 (26)
Type of family	Nuclear	39 (78)	38 (76)
	Joint	11 (22)	12 (24)
Type of house	Pucca	28 (56)	26 (52)
	Semi-pucca	17 (34)	18 (36)
	Kutcha	5 (10)	6 (12)

Table 2: Frequency and percentage distribution of clinical variables among the experimental and control groups (N = 100)

Clinical variable	Category	Experimental group (n = 50) n (%)	Control group (n = 50) n (%)
Duration of diabetes mellitus	Less than 5 years	12 (24)	14 (28)
	5–8 years	20 (40)	19 (38)
	More than 8 years	18 (36)	17 (34)
Dietary pattern	Vegetarian	11 (22)	13 (26)
	Non-vegetarian	39 (78)	37 (74)
Physical activity	Sedentary	12 (24)	14 (28)
	Moderate worker	33 (66)	31 (62)
	Heavy worker	5 (10)	5 (10)
Hypertension	Present	26 (52)	23 (46)
	Absent	24 (48)	27 (54)
Anemia	Absent	18 (36)	20 (40)
	Mild	22 (44)	21 (42)
	Moderate	10 (20)	9 (18)
Body mass index	Normal (18.5–24.9)	9 (18)	11 (22)
	Overweight (25–29.9)	27 (54)	25 (50)
	Obese (30 and above)	14 (28)	14 (28)

Treatment modality	Oral hypoglycaemic agents	31 (62)	33 (66)
	Insulin	11 (22)	10 (20)
	Both	8 (16)	7 (14)
HbA1c (%)	7.0–8.0	15 (30)	18 (36)
	8.1–10.0	21 (42)	22 (44)
	More than 10.0	14 (28)	10 (20)
Random blood sugar (mg/dl)	Less than 200	16 (32)	18 (36)
	200–300	25 (50)	23 (46)
	More than 300	9 (18)	9 (18)

Table 3: Comparison of mean peripheral neuropathy scores of the right lower extremity between the experimental and control groups (N = 100)

Assessment	Experimental group (n = 50) Mean ± SD	Control group (n = 50) Mean ± SD	Mean difference	t value (df = 98)	p value
Pre-test	15.68 ± 5.12	16.92 ± 3.94	1.24	1.36	0.176 (NS)
Post-test I (Day 5)	12.74 ± 4.36	16.98 ± 3.61	4.24	5.3	0.0001*
Post-test II (Day 10)	7.62 ± 3.58	16.84 ± 3.47	9.22	13.06	0.0001*
Post-test III (Day 15)	3.94 ± 3.04	16.72 ± 3.55	12.78	19.34	0.0001*

** Significant at p < 0.05; NS = not significant*

Table 4: Comparison of mean peripheral neuropathy scores of the left lower extremity between the experimental and control groups (N = 100)

Assessment	Experimental group (n = 50) Mean ± SD	Control group (n = 50) Mean ± SD	Mean difference	t value (df = 98)	p value
Pre-test	20.42 ± 5.86	21.06 ± 4.72	0.64	0.6	0.549 (NS)
Post-test I (Day 5)	16.38 ± 5.12	20.94 ± 4.58	4.56	4.69	0.0001*
Post-test II (Day 10)	11.44 ± 4.35	20.86 ± 4.61	9.42	10.51	0.0001*
Post-test III (Day 15)	7.48 ± 3.72	20.72 ± 4.44	13.24	16.15	0.0001*

** Significant at p < 0.05; NS = not significant*

Table 5: Repeated-measures ANOVA of peripheral neuropathy scores across the four assessment points (N = 100)

Group	Extremity	Source of variation	Sum of squares	df	Mean square	F value	p value
Experimental (n = 50)	Right leg	Between assessments	4218.62	3	1406.21	412.36	0.0001*
		Error	501.28	147	3.41		
Experimental (n = 50)	Left leg	Between assessments	5136.44	3	1712.15	536.84	0.0001*
		Error	468.82	147	3.19		
Control (n = 50)	Right leg	Between assessments	8.94	3	2.98	0.842	0.473 (NS)
		Error	520.16	147	3.54		
Control (n = 50)	Left leg	Between assessments	12.36	3	4.12	1.126	0.341 (NS)
		Error	537.84	147	3.66		

** Significant at p < 0.05; NS = not significant*

Table 6: Paired t-test comparison of pre-test and post-test peripheral neuropathy scores within the experimental group (n = 50)

Extremity	Comparison	Mean difference	SD of difference	t value (df = 49)	p value
Right leg	Pre-test vs Post-test I	2.94	2.1	9.9	0.0001*
	Pre-test vs Post-test II	8.06	3.4	16.76	0.0001*
	Pre-test vs Post-test III	11.74	3.9	21.28	0.0001*
Left leg	Pre-test vs Post-test I	4.04	2.6	10.98	0.0001*
	Pre-test vs Post-test II	8.98	3.6	17.64	0.0001*
	Pre-test vs Post-test III	12.94	4.2	21.79	0.0001*

** Significant at p < 0.05*

Table 7: Paired t-test comparison of pre-test and post-test III peripheral neuropathy scores within the control group (n = 50)

Extremity	Comparison	Mean difference	SD of difference	t value (df = 49)	p value
Right leg	Pre-test vs Post-test III	0.2	1.86	0.76	0.451 (NS)
Left leg	Pre-test vs Post-test III	0.34	1.94	1.24	0.221 (NS)

NS = not significant

Table 8: Association between the level of peripheral neuropathy symptoms and selected demographic and clinical variables (N = 100)

Variable	χ^2 value	df	p value	Inference
Age	5.62	6	0.467	Not significant
Gender	1.84	2	0.398	Not significant
Education	4.96	6	0.549	Not significant
Occupation	6.18	6	0.403	Not significant
Marital status	2.34	4	0.673	Not significant
Annual income	3.76	4	0.439	Not significant
Type of family	**6.84**	**2**	**0.033**	**Significant***
Type of house	3.12	4	0.538	Not significant
Duration of diabetes mellitus	**11.42**	**4**	**0.022**	**Significant***
Dietary pattern	1.96	2	0.375	Not significant
Physical activity	5.44	4	0.245	Not significant
Hypertension	2.68	2	0.262	Not significant
Anemia	4.28	4	0.369	Not significant
Body mass index	6.02	4	0.198	Not significant
Treatment modality	3.54	4	0.472	Not significant

HbA1c	7.18	4	0.127	Not significant
Random blood sugar	4.86	4	0.302	Not significant

* *Significant at p < 0.05*

Discussion:

The present study was conducted to evaluate the effectiveness of Buerger Allen Exercise on peripheral neuropathy symptoms among patients with Type 2 diabetes mellitus. The findings showed significant improvement in lower extremity peripheral neuropathy symptoms among participants who received the intervention. The study findings showed that the experimental group experienced substantial reduction in neuropathy scores from pre-test to post-test III in both right and left lower extremities. The repeated-measures ANOVA findings demonstrated highly significant improvement in the experimental group compared to the control group. These findings strongly support the effectiveness of Buerger Allen Exercise as a non-pharmacological intervention for diabetic peripheral neuropathy. The observed improvement may be attributed to enhanced peripheral circulation resulting from gravitational modulation and active foot movements during the exercise. Elevation and dependency positions facilitate arterial filling, venous drainage and improved oxygen supply to peripheral tissues. Active ankle and toe movements stimulate muscle pump action, which further enhances vascular perfusion and reduces tissue ischemia **[12].** The findings of the present study are consistent with previous research studies that showed the beneficial effects of exercise interventions on diabetic neuropathy. Radhika *et al.* (2020) **[13]** reported significant improvement in lower limb perfusion and neuropathy symptoms following implementation of Buerger Allen Exercise among diabetic patients. Similarly, Vijayabarathi reported positive effects of Buerger Allen Exercise on diabetic foot healing and peripheral circulation. The present study also showed progressive reduction in neuropathy symptoms over repeated assessments, indicating cumulative therapeutic benefit with regular performance of the exercise. Participants in the experimental group showed greater improvement during post-test II and post-test III assessments compared to post-test I, suggesting that sustained intervention over time is necessary to achieve maximum benefit. In contrast, the control group did not show statistically significant improvement in peripheral neuropathy symptoms. This finding further strengthens the evidence that the observed changes in the experimental group were attributable to the intervention rather than natural recovery or routine care as observed by Dixit *et al.* (2023) **[14].** Peripheral neuropathy is one of the major contributors to diabetic foot complications and disability among patients with Type 2 diabetes mellitus. Improvement in lower extremity circulation and sensory function through simple exercise interventions may play an important role in preventing diabetic foot ulceration and improving functional mobility **[15].** Francis *et al.* **[16]** further demonstrated that Buerger Allen Exercise significantly improved peripheral circulation and reduced symptoms of diabetic peripheral neuropathy, supporting its role as an effective adjunctive therapy in routine diabetic care. Likewise, Saleh *et al.* **[17]** reported that patients performing Buerger Allen Exercise experienced marked improvements in lower extremity circulation, peripheral sensation and functional status compared with those receiving conventional care alone. The present study also showed a progressive reduction in neuropathy symptoms across repeated assessments, indicating a cumulative therapeutic benefit with continued exercise practice. Participants in the experimental group exhibited greater improvement during post-test II and post-test III than during post-test I, suggesting that sustained performance of the exercise is necessary to achieve optimal clinical outcomes. Similar findings were reported by Thakur *et al.* **[18]**, who emphasized that structured exercise interventions improve peripheral vascular function, glycemic control and neuropathic manifestations in patients with Type 2 diabetes mellitus. Comparable results were also observed by Ahmed *et al.* **[19]**, and Abbass *et al.* **[20]** who found significant reductions in neuropathic symptoms and improvements in lower limb circulation following consistent implementation of Buerger Allen Exercise over several weeks. The findings of the present study provide strong evidence supporting the clinical utility of Buerger Allen Exercise in improving peripheral neuropathy symptoms among patients with Type 2 diabetes mellitus.

Conclusion:

We show the important role of nurses in implementing non-pharmacological interventions for diabetic patients. Buerger Allen Exercise is safe, inexpensive, easy to administer and suitable for both hospital and home settings. Thus, it can be incorporated into routine diabetic care protocols for patients at risk of peripheral neuropathy and diabetic foot complications.

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