

Effectiveness of Buerger-Allen Exercise on Lower Extremity Perfusion and Peripheral Neuropathy Symptoms among Patients with Diabetes Mellitus

Abstract

Background: Buerger-Allen Exercise (BAE) promote Lower Extremity Perfusion (LEP) via the wound healing process and reduce Peripheral Neuropathy Symptoms (PNS) among Diabetes Mellitus (DM) patients. We study the efficacy of BAE on LEP and PNS among patients with DM. **Materials and Methods:** This quasi-experimental study was conducted prospectively from July to October 2017. Fifty DM patients between the ages of 30 and 75 from both genders were selected using a purposive sampling technique and were assessed for LEP with a manual Ankle-Brachial Index (ABI) scale and assessed for PNS with Michigan Neuropathy Screening Instrument (MNSI). The BAE was demonstrated for 4 consecutive days. The intervention was repeated five times per day for each patient and the posttest was conducted 5th day using the same tools. **Results:** The majority ($n = 75$, 75%) were 60–69 age group and 98% had education till primary school. 62% had diabetes and 20% of them had a history of peripheral arterial disease. 50% of participants had mildly impaired perfusion during pretest whereas abnormal neuropathy was seen in more than 70% cases which decreased posttest. A significant difference in PNS was seen after the implementation of BAE in both right LEP ($t_{48} = 6.81$, $p < 0.001$) and left LEP ($t_{48} = 5.21$, $p < 0.001$). **Conclusions:** BAE has to be taught to the patients with DM in improving the level of LEP and can be encouraged to practice in the hospital and home care setup.

Keywords: Diabetic neuropathies, extremities, lower limb exercise, perfusion

Introduction

According to the International Diabetes Federation South East Asia (IDF SEA), there are 69.1 million diabetes cases in India in 2015 and the prevalence of diabetes in adults 20–79 years was 8.70%.^[1-3] Diabetes increases the risk of lower extremity amputations because of the lack of diabetic management and care that lead to infected, nonhealing foot ulcers. Among all other complications, peripheral neuropathy is a well-known microvascular complication attribute to chronic hyperglycemia which leads to sensory loss and damage-causing lower extremity amputations.^[4,5] In India, there is a deficit in diabetic awareness programs because of low coverage. If accounts were taken of the applicable social and economic settings, the diabetes awareness program for the self-management of diabetes could reduce the cost and resources. On the other hand, Indian urban design and transport

policies enhance the problem even more by further use of vehicles, decrease the use of physical activity, makes ignoring morning walking which makes the lifestyle more dependent on the modern facility.^[6,7]

Diabetes cannot be cured but it shows a good prognosis with self-management which includes lifestyle changes like regular physical activity, developing healthy eating habits, maintaining normal body weight, adherence to treatment, cessation of smoking, and moderation in alcohol consumption. There are many ways to manage diabetic neuropathy includes medications (in the form of tablets or insulin injection), dietary modifications, walking, exercise and following complementary, and alternative therapy. Among which performing exercise is one of the easiest and cost-effective ways of treatment which gives many more advantages for the patients while giving management for diabetic

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patients.^[8,9] Especially when the patient is suffering from diabetic neuropathy and foot ulcer performing exercise will help the patient to improve vascularity.

Buerger-Allen Exercise (BAE) is one of the types of exercise performed to promote Lower Extremity Perfusion (LEP) whereby promoting the wound healing process and reduce Peripheral Neuropathy Symptoms (PNS) among Diabetes Mellitus (DM) patients. BAE is an active postural exercise in which gravity alternatively fills and empties the blood vessels for preventing Peripheral vascular diseases and promoting collateral circulation in lower extremities.^[9,10] In this study, we aimed to identify the patients who are at risk and bring about the important changes in the health of the diabetic population, based on promoting healthy lifestyles. Apart from this, we also evaluated if the high-risk group with prompt intervention can prevent the development of complications in diabetic affected individuals. Therefore, we determine the effectiveness of BAE on LEP and PNS among patients with DM. We also assayed the relationship between PNS and perfusion of LEP among patients in selected demographic variables among patients with DM.

Materials and Methods

This study was a quasi-experimental design and prospectively conducted from July 2017 to October 2017 at the medical and surgical wards of Sri Ramachandra Hospital, Porur, Chennai. The sample size was calculated by power analysis, power 80%, and alpha error 5%. The calculated sample size was 35. After adding 10%, to the sample size, considering the attrition, the sample size was estimated sample size as 50. Purposive sampling technique was adopted for the study. Patients between the ages of 30 and 75 from both genders diagnosed with DM, who can understand Tamil and/or English and willing to participate in the study, were included in this study. Patients suffering from grade-IV foot ulcers and gangrene, severe cardiac diseases, and critically ill were not enrolled in the study. Background variable: it consists of two parts. Part-A: demographic variables: age, gender, diet, education, the habit of alcoholism, occupation, type of job, duration of DM, family Peripheral Artery Disease (PAD), the habit of smoking, the habit of alcoholism. Part-B: clinical variables: such as duration of DM, family history of PAD. The manual Ankle-Brachial Index (ABI) was performed by a researcher using Blood Pressure (BP) cuff for the measurement of LEP. To calculate the ABI, each ankle systolic pressure was divided by the brachial systolic pressure and the higher of the two systolic pressures for each leg was divided by the higher of the two arm pressures to get the right and left ABI. The score was interpreted as above 0.9 (normal perfusion), 0.71–0.90 (mildly impaired perfusion), 0.41–0.70 (moderately impaired perfusion), 0–0.40 (severely impaired perfusion). Michigan Neuropathy Screening Instrument (MNSI) consists of two sections: the patient version questionnaire contains 15 questions

and the examination version also contains 15 questions. The primary part of the MNSI questionnaire asks the participants about the presence or absence of symptoms related to Diabetic Peripheral Neuropathy (DPN). A score of ≥ 7 is taken as positive for the DPN. The reliability of the tool was internally consistent and were positively correlated ($r = 0.70$, $p < 0.001$). The reliability of the manual BP method by Kappa statistics was 0.84 on the right side and 0.77 on the left side ($p = 0.001$). The demonstration-cum-teaching program includes the definition, purpose, and steps of the BAE. The teaching program was imparted using the demonstration BAE method for 4 consecutive days, demonstration consists of three steps of BAE. The intervention was repeated five times per day (morning 8 am to 1 pm two times and noon from 2 pm to 5 pm three times). The planned teaching program content was developed by the researcher based on the literature. The independent variable in the study was the BAE intervention and the dependent variables were LEP and PNS. Phase I: 50 participants were recruited by purposive sampling technique and considering the sampling criteria. In phase I, the lower limb perfusion by ABI and the peripheral neuropathy symptoms by MNSI scale were assessed for five diabetic mellitus patients per day. Phase II: the BAE intervention was given to 50 DM inpatient bedside. The samples were provided with a calm environment for BAE. Following the learning phase, the second phase (performing phase) was carried out. In this phase, the participants were asked to perform BAE every day 5–6 times for 4 days under the supervision of the investigator. Phase III: LEP and PNS were assessed (posttest) on the 5th day with the same tools.

Data were analyzed using the statistical package for social science (SPSS ver 19. IBM Corporation, USA) program. The collected data were analyzed by descriptive statistics (frequency, mean, percentage, and standard deviation) and inferential statistics (paired *t*-test correlation coefficient) were used to compare two sets of data (pre-intervention and post-intervention). The $p < 0.05$ level of significance was used for considering significant outcomes.

Ethical consideration

The study was performed after the approval (CSP/17/June/59/184) dated 17 June 2017 from the institutional ethics committee, Sri Ramachandra Institute of Higher Education and Research. Patients' consent was obtained in written and preserved.

Results

Above 75% of the sampling population was from the age group of 60 to 69 or above and 58% of them were male. 98% of them had education at least till primary school. 62% of them were diabetic for more than 10 years and 20% had a family history of peripheral arterial disease.

62% of diabetic patients were not alcoholics and 56% of diabetic patients were not smokers. During the pretest, more than 50% of participants had mildly impaired perfusion and close to 16–18% had right and left limb normal perfusion. After the posttest, mildly impaired perfusion was decreased and the normal perfusion was seen increasing in 34–36%. The examination version showed that normal and abnormal neuropathy was less than patients version in both pre- and post-cases. Abnormal neuropathy was seen in more than 70% cases which were decreased posttest considerably [Table 1]. Results show statistically significant improvement between pretest LEP mean score ($t_{48} = 6.81, p < 0.001$) and posttest LEP ($t_{48} = 5.21, p < 0.001$) mean score due to BAE [Table 2]. The mean score for PNS

shows a decrease of 9.02 to 8.36 and 4.24 to 3.70 in patients version and health care assessment version, respectively. There was a statistically considerable relationship between the posttest PNS (patient-version questionnaire) and gender ($t_{50} = 2.70, p = 0.009$) and type of job ($t_{52} = 0.99, p = 0.005$) with DM patients [Table 3]. The table above shows that there was no statistically significant association between the PNS (assessment version) scores and demographic variables of the patients with DM [Table 3].

Discussion

This study was undertaken to assess the efficacy of BAE on LEP and PNS among patients with DM. The prevention of problems of diabetic foot is the major goal. Peripheral

Table 1: LEP* scores, pretest, and posttest peripheral neuropathy, mean scores of the effectiveness of BAE on LEP, and mean scores of BAE on PNS*****

LEP	LEP score			
	Pretest (n=100)		Posttest (n=100)	
	Right limb n (%)	Left limb n (%)	Right limb n (%)	Left limb n (%)
Normal perfusion	8 (16%)	9 (18%)	17 (34%)	18 (36%)
Mildly impaired perfusion	28 (56%)	25 (50%)	25 (50%)	22 (44%)
Moderately impaired perfusion	8 (16%)	3 (16%)	8 (6%)	3 (6%)
Severely impaired perfusion	1 (2%)	2 (4%)	-	1 (2%)
Amputated extremities	5 (10%)	6 (12%)	5 (10%)	6 (12%)

Variable	PNS among patients			
	Pretest		Posttest	
	Patient version questionnaire F (%)	Examination version F (%)	Patient version F (%)	Examination version F (%)
Normal (no significant [PNS])	15 (30%)	9 (18%)	20 (40%)	15 (30%)
Abnormal (positively significant [PNS])	35 (70%)	41 (82%)	30 (60%)	35 (70%)

*LEP: Lower extremity perfusion; ** BAE: Buerger Allen Exercise,***PNS: Peripheral Neuropathy Symptoms

Table 2: Relationship between Peripheral Neuropathy Symptoms and Lower Extremity Perfusion among patients with Diabetes Mellitus (N=50)

	Peripheral neuropathy symptoms- patient version questionnaire			Peripheral neuropathy symptoms -examination version			Lower extremity perfusion – Left Limb			Lower extremity perfusion-Right Limb		
	r	df	p	r	df	p	r	df	p	r	df	p
Peripheral neuropathy symptoms patient version questionnaire	0.94	4	<0.001	0.84	4	0.004	0.08	4	0.618	0.10	4	0.512
Peripheral neuropathy symptoms examination version	0.40	4	0.004	0.94	4	<0.001	0.08	4	0.587	0.25	4	0.001
Lower extremity perfusion-left	0.99	4	0.002	0.13	4	0.417	1	4	-	0.19	4	0.386
Lower extremity perfusion-right	0.07	4	0.649	0.24	4	0.111	0.14	4	0.442	0.13	4	0.442

Pretest and posttest PNS					
Variables	Pretest mean (SD)	Posttest mean (SD)	t	df	p
Right LEP	0.73 (0.12)	0.83 (0.12)	6.81	2	<0.001
Left LEP	0.79 (0.14)	0.84 (0.13)	5.21	2	<0.001

Table 3: Association of background variables with PNS patient and assessment version questionnaire among patients with diabetes mellitus (n=50)

Demographic variables	PNS (patient version questionnaire)-Posttest				PNS (assessment version)-Posttest			
	n	Mean (SD)	t/F	p	n	Mean (SD)	t/F	p
Age in Years								
40-49	1	6 (1.20)			1	3.50 (0.20)	F=0.60	0.54
50-59	11	8.36 (1.90)	F=0.57	0.637	11	3.59 (0.80)		
60-69	30	8.47 (1.90)			30	4.63 (1.60)		
Above 69	8	8.25 (1.60)			8	3.75 (0.90)		
Gender								
Male	27	7.79 (1.70)	t=2.70	0.009	27	3.44 (1.20)	t=0.60	0.54
Female	18	9.14 (1.90)			18	4.11 (1.40)		
Diet pattern								
Vegetarian	13	7.85 (1.90)	t=1.16	0.248	13	3.69 (1.30)	t=1.10	0.259
Nonvegetarian	37	8.54 (1.80)			37	3.74 (1.30)		
Education								
No formal education	1	7 (1.10)			1	2.0 (0.80)	F=0.37	0.772
Primary	23	8.65 (2.00)	F=0.70	0.555	23	3.78 (0.90)		
Higher secondary school	23	8.04 (1.70)			23	3.8 (0.90)		
Graduate	3	9 (2.40)			3	3.33 (0.90)		
Occupation								
Unemployed	6	9.17 (1.70)			6	4.16 (1.70)	F=1.13	0.34
Business	24	7.92 (1.60)	F=2.15	0.106	24	3.27 (1.40)		
Govt./private sector	11	8.0 (1.80)			11	3.59 (1.40)		
Others (farmer and coolie)	9	9.44 (2.30)			9	4.83 (1.50)		
Type of job								
Sedentary	1	12 (1.20)			1	6.5 (1.70)	F=1.45	0.24
Standing	31	7.71 (1.70)	F=0.99	0.005	31	3.41 (1.30)		
Both sedentary and standing	14	9.14 (1.50)			14	4.1 (1.90)		
None	4	9.75 (1.00)			4	4.12 (1.80)		
Duration of diabetes mellitus								
1-5 years	-	-			-	-		
5-10 years	19	7.95 (1.50)	t=1.80	0.078	19	3.21 (1.20)	t=1.80	0.078
More than 10 years	31	8.61 (2.00)			31	4.15 (1.40)		
Family history of PAD*								
Yes	10	8.0 (1.30)	t=1.25	0.21	10	3.65 (1.90)	t=1.25	0.21
No	40	8.45 (2.0)			40	3.75 (1.70)		
Habit of alcoholism								
Yes	19	7.79 (1.50)	t=1.53	0.68	19	3.31 (1.70)	t=1.53	0.68
No	31	8.71 (2.00)			31	3.98 (1.80)		
Habit of smoking								
Yes	22	7.86 (1.70)	t=1.36	0.18	22	3.79 (1.80)	t=1.36	0.18
No	28	8.75 (1.90)			28	3.67 (1.80)		

*PAD: Peripheral Arterial Disease

neuropathy contributes to diabetic foot complications and the possibility of ulceration of lower extremities in diabetic patients is approximately 15–59 times more than in the nondiabetic individuals.^[11] Exercise is the fundamental principle for preventing peripheral neuropathy among DM patients. More than 50% of participants who had mildly impaired perfusion had a feeling of improvement and impaired perfusion was decreased to normal perfusion. Normal and abnormal neuropathy was less or similar in both pre- and post- cases. Abnormal neuropathy was seen

in more than 70.00% cases which were decreased after the posttest considerably.

A study by Gill *et al.* (2014) was conducted to assess the effectiveness of the exercise program on glucose control and risk factors for complications in type II DM patients. The study was done on three different measures (aerobic, resistance, and combined training). The study lasted for >12 weeks among 1,003 type II DM patients. The study concluded that all forms of exercise program have the benefit

of controlling blood glucose like dietary, drug, and insulin treatments which have clinical importance.^[12] The majority of the DM patients had mildly impaired perfusion. On the posttest, the normal perfusion increased considerably in the right and left limb. There was a statistically considerable difference in the mean score for exercise effect on LEP of patients with DM between the pretest and posttest at the level of $p < 0.001$. On the posttest, the number of patients with no significant PNS was increased. There was a significant difference in the mean score of BAE on PNS among DM between the pretest and posttest at $p < 0.001$ level. The study depicted that there is a significant correlation between PNS and left and right LEP at the $p < 0.01$ and $p < 0.05$ level.

The mean score for PNS was decreased significantly after the implementation of BAE. Posttest PNS and LEP were improved a lot. Study on occurrence and risk factors related to peripheral neuropathy among ≥ 30 years of both genders among Type 2 DM patients, showed that only 24.50% had neuropathy. The part of males affected by neuropathy conditions was more than females. Neuropathy was prevalent in those people with high systolic and diastolic blood pressure.^[11] Gill *et al.* (2011), in his study, stated that the overall prevalence of DPN was 29.20% prevalence had an increasing trend with age.^[12] A descriptive study showed that mobility limitation in adults diagnosed with DM was more than those without diagnosed diabetes in each age and sex group.^[13] Effectiveness of BAE was analyzed in a few studies in improving the peripheral circulation among clients with DM and study revealed that posttest mean score was statistically significant and on comparison of pre- and posttest findings showed that the mean score of lower extremity pain reduced with BAE on LEP.^[13]

Regarding the limitation, the self-report method utilized to collect data on PNS via questionnaire might have posed potential issues concerning the accuracy of the information. The participants expressed that they felt easy to remember and perform the BAE in the hospital and also home care to set without any observation.

Conclusion

The present study assessed the effectiveness of BAE on the level of LEP and PNS among patients with DM. This study result was evident that the exercise provided to patients is effective enough to help in improving the LEP and reduction of PNS. The nurse should have skills to assess the LEP and PNS among patients with DM and also should teach BAE to DM patients in the hospital and home care setting to prevent further complications including peripheral arterial disease and diabetic foot ulcers.

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Conflicts of interest

Nothing to declare.

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