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Original Research Article

A Study to Assess the Effectiveness of Buerger Allen Exercise on Foot Perfusion among Patients with Diabetes Mellitus Admitted in Selected Hospital of Ambala, Haryana

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ABSTRACT

Diabetes Mellitus (DM) is a metabolic disorder which is characterized with increased glucose level in the blood, resulting from defect in the insulin secretion, insulin action, or both. In advance stage of the disease, foot perfusion of patients is decreased. It can be assessed by Ankle Brachial Index (ABI) score and Capillary Refill Time (CRT). Buerger Allen Exercise is an effective intervention for improving the foot perfusion of diabetes mellitus patients. The objective is to assess the effectiveness of Buerger Allen Exercise on foot perfusion among patients with diabetes mellitus. Sixty patients were selected by convenience sampling technique and randomized into two groups experimental (n=30) and control (n=30) by computer generated code method. The study findings revealed that the post intervention mean ABI score in experimental group (Right Mean=0.95, Left Mean=0.94) was significantly higher than control group (Right Mean=0.86, Left Mean=0.85) (p=0.001***). The post intervention CRT was lower in experimental group than control group (p=0.001***) respectively. The use of Buerger Allen Exercise is effective in improving the foot perfusion in terms of ABI score, reducing the capillary refill time. Therefore, it is recommended that 'Buerger Allen Exercise' can be used to improve the foot perfusion of diabetes mellitus patients.

Key words: Buerger Allen Exercise, Ankle Brachial Index (ABI) score, Capillary Refill Time (CRT)

INTRODUCTION

Diabetes Mellitus (DM) is a metabolic disorder which is characterized with increased glucose level in the blood, resulting from defect in the insulin secretion, insulin action, or both. Globally, an expected 422 million of adult population are living with diabetes (WHO). Diabetes presently affects more than 62 million of Indian population, which is more than 7.1% of the adults. [1]

The risk of Peripheral Vascular Disease (PVD) is increased in patients who are suffering from diabetes mellitus, occurs earlier and is often more severe and diffuse. The presence of PVD, apart from its increased risk of claudication, ischemic ulcers, gangrene and possible amputation

will also occur, is also a marker for generalized atherosclerosis and a strong predictor for cardiovascular ischemic events. A person with long standing Diabetes mellitus develops complication of PAD, which leads to grave complications like gangrene in the lower limbs. [2]

A patient with diabetes and peripheral arterial disease is more likely to present with an ischemic ulcer or gangrene than a patient without diabetes mellitus. The use of ankle-brachial-pressure index in the clinic and bedside provide a measure of blood flow to the ankle. This could help early detection, initiate early therapy and may thus reduce the risk of critical limb ischemia and limb loss. [3]

There are many techniques to improve the foot perfusion such as relaxation technique, warm feet technique and treatments are available to relieve the pain and discomfort of PAD and neuropathy. Drug treatment is often the first one offered. For PAD, pain relievers, blood thinners, and other drugs that improve blood flow may be prescribed. [4]

Buerger Allen Exercise is one of the interventions to stimulate the development of collateral circulation in the legs. The mechanism of Buerger's exercises use gravitational changes in positions that are applied to the smooth musculature of vessels and to the vascular bed. Gravity helps alternately to empty and to fill the blood columns, which can eventually increase transportation of blood through them. [5]

Primary Care Providers should focus on prevention by early recognition and prevention of PAD to those at increased risk. An awareness of diagnostic and treatment strategies will enable primary care providers to educate patients. This will help to improve both concordance with treatment and disease outcome. [6]

MATERIALS AND METHODS

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

H_1: There will be a significant difference in the mean post test ABI score among patients with diabetes mellitus in experimental and control group after administration of Buerger Allen Exercise.

H_2: There will be a significant difference in the CRT among patients with diabetes mellitus in experimental and control group after administration of Buerger Allen Exercise.

Research Design

True Experimental i.e. - "Pretest posttest design"

Setting

Maharishi Markandeshwar Institute of Medical Sciences and Research Hospital Mullana, Haryana.

Sample Selection

Consent was taken from the patients regarding their willingness to participate in the research project. Total 60 patients were selected by convenience sampling technique and randomized into two groups experimental (n=30) and control (n=30) by computer generated code method.

Inclusion Criteria

- Age ≥18 years
- Willing to participate in study
- Available during the study period

Exclusion Criteria

- Diagnosed with foot ulcer or foot gangrene.
- Critically ill.
- Having Deep Vein Thrombosis (DVT)

Ethical Clearance

Ethical approval was obtained from institutional ethical committee of M.M (Deemed to be University), Mullana [IEC-958].

Period of Investigation

October 2017 to December 2017

Operational Definition

1. **Effectiveness:** refers to significant improvement in foot perfusion as determined by changes in ABI ratio, CRT, peripheral pulse rate after administration of Buerger Allen exercise.
2. **Buerger Allen exercise:** it refers to active postural exercise administered by

the researcher intended to improve the peripheral circulation and composing of three steps i.e. 45 degree elevation by using foot board, 90 degree dependency, 180 degree horizontal position of the legs. Buerger Allen Exercise (BAE) to be administered for 7-11 minutes, two times a day for 5 days. One time comprises of 5 cycles of BAE.

3. **Foot perfusion:** It refers to blood flow to the lower extremity as evidenced by Ankle Brachial Index (ABI) score and Capillary Refill Time (CRT).
   ABI: ABI is the ratio of systolic blood pressure at the ankle (dorsalis pedis/posterior tibialis artery) to the systolic blood pressure in the brachial artery. 0.9-1.3 indicates normal range of ABI, Less than 0.9 indicates PAD
   CRT: It refers to the time needed for the capillary to refill after pressing the great toe for five seconds and then releasing it and measured by noting the time needed for the colour to return back. CRT <2 seconds indicates normal CRT and >2 seconds indicates delayed CRT.
4. **Patients:** It refers to adult clients aged ≥18 years, and diagnosed with diabetes mellitus.

Tools and Techniques

The inter-rater and intra-rater reliability of **Ankle Brachial Index ratio (ABI)** was determined by using Pearson Correlation and was found to be 0.86 and 0.87. The inter-rater and intra-rater reliability of **Capillary Refill Time (CRT)** was determined by using Pearson Correlation and was found to be 0.87 and 0.88. Buerger Allen Exercise was administered in experimental group. Buerger Allen Exercise is a active postural exercise administered by the researcher intended to improve the peripheral circulation and composing of three steps i.e. 45 degree elevation by using foot board, 90 degree dependency, 180 degree horizontal position of the legs. Buerger Allen Exercise (BAE) to be administered for 7-11 minutes, two times a day for 5 days. One time comprises of 5 cycles of BAE. The pre and post interventional foot perfusion score was assessed in both the groups by using foot perfusion scale. The data was collected by record analysis and biophysiological measurements.

Statistical Analysis

Data was entered in Master Data Sheet and analyzed using SPSS software version 20.0. The data obtained was analyzed in terms of objectives of the study using both descriptive statistics and inferential statistics i.e. mean, median, standard deviation, range, "t" test, ANOVA and chi square test. A statistical significance was considered at $P<0.05$.

RESULTS

Sample Characteristics and clinical variables of patients:

Out of 60 patients, more than half of the patients in experimental group (53.3%) were in the age group of 50-65 years and control group (63.3%) were in the age group of 50-65 years. Half of the patients in experimental group were female (50.0%) and in control group, majority of the patients were female (73.3%). Nearly half of the patients in experimental group (46.7%) and more than half of the patients in control group (63.3%) were having duration of illness less than 5 years. More than half of the patients in both the experimental group (56.7%) and control group (56.7%) were having co-morbid illness. More than half of patients in experimental group (63.3%) and most of patients in control group (86.7%) were having normal BMI. More than half of patients in experimental group (56.7%) used to walk for >30 minutes per day and more than half of patients in control group (53.3%) walked for 15-30 minutes per day. More than half of the patients in experimental group (56.7%) and nearly half of the patients in control group (46.7%) were having haemoglobin >11gm/dl. More than $1/3^{rd}$ of patients in experimental group (33.3%) were having stage 2 and stage 3 hypertension and more than $1/3^{rd}$ of patients in control group (33.3%) were having stage 1 hypertension. Majority of the patients in

experimental group (70%) and half of patients in control group (50%) were having fasting blood sugar level >270 mg/dl. 1/3rd of patients in experimental group (30%) were having random blood sugar level between 351- 400 mg/dl and >400 mg/dl and nearly 1/3rd of patients in control group (26.7%) were having random blood sugar level >400 mg/dl. Nearly 1/3rd of patients in both the experimental group (26.7%) and control group (26.7%) were having post prandial blood sugar level between 391- 440 mg/dl.

Chi square was applied and findings show that both groups were homogeneous with respect to sample characteristics and clinical variables.

Table 1: Range, Mean, Standard deviation of ABI score before administration of Buerger Allen Exercise in Experimental and Control Group N=60

Variables	Group	Range	Mean±SD	Median
Right ABI	Experimental group	0.75-0.95	0.84±0.48	0.84
	Control group	0.77-0.96	0.86±0.46	0.86
Left ABI	Experimental group	0.75-0.95	0.83±0.47	0.83
	Control group	0.77-0.96	0.86±0.50	0.87

Minimum score= 0.75 Maximum score=0.96

The data presented in Table 1 shows the Range, Mean, Standard deviation of ABI score in experimental and control group. The data shows that the mean and median of right ABI score of experimental group (0.84±0.48; 0.84) was lower than the control group (0.86±0.46; 0.86). The mean and median of left ABI score of experimental group (0.83±0.47; 0.83) was lower than the control group (0.86±0.50; 0.87).

Table 2: Mean, Mean difference, Standard Error of Mean difference and 't' value of ABI score of Experimental and Control Group before administration of Buerger Allen Exercise Intervention N=60

Variables	Group	Mean	M_D	SE_{MD}	t value	df	P value
Right ABI	Experimental Group	0.84	0.02	0.01	2.09	58	**0.04***
	Control Group	0.86					
Left ABI	Experimental Group	0.83	0.28	0.01	2.27	58	**0.02***
	Control Group	0.86					

***Significant (p<0.05) t (58)=1.67**

The data presented in Table 2 shows the right Ankle Brachial Index (ABI) score of patients before administration of Buerger Allen Exercise in experimental group (Mean=0.84) was significantly (p=0.04) lower than the control group (Mean=0.86). The left Ankle Brachial Index (ABI) score of patients in experimental group (Mean=0.83) was significantly (p=0.02) lower than the control group (Mean=0.86). Therefore, it is inferred that the patients in experimental and control group were heterogenous and incomparable with regard to left and right ABI score before administration of Buerger Allen Exercise. The patients in control group had significantly higher ABI score than the experimental group.

Table 3: Chi-Square showing Comparison of Experimental and Control group in terms of CRT before administration of Buerger Allen Exercise N=60

Sr. No.	Selected variables	Experimental Group (n=30) f(%)	Control Group (n=30) f(%)	Chi square (χ^2)	d.f.	p value
1	**CRT Right (Great toe)**					
1.1	<2 sec	05 (16.7)	08 (26.7)	0.54	01	0.46 NS
1.2	>2 sec	25 (83.3)	22 (73.3)			
2	**CRT Left (Great toe)**					
2.1	<2 sec	03 (10.0)	06 (20.0)	0.37	01	0.543 NS
2.2	>2 sec	27 (90.0)	24 (80)			

χ^2 (1)=3.84 **NS Not Significant (p≥0.05)**

The data presented in Table 3 shows the capillary refill time of patients before administration of Buerger Allen Exercise in Experimental group and Control group. It

depicts majority of the patients in Experimental group (83.3%) and Control group (73.3%) were having right capillary refill time >2 seconds. Most of the patients in experimental group (90%) and control group (80%) were having left capillary refill time >2 seconds.

Chi square was computed to determine the homogeneity of experimental and control group in terms of capillary refill time before administration of Buerger Allen Exercise. The findings shows that both groups were homogeneous/similar with respect to right capillary refill time (χ^2= 0.54, p=0.46) and left capillary refill time (χ^2=0.37, p=0.54). Therefore, it can be inferred that the patients in experimental and control group were homogenous and comparable in terms of capillary refill time before administration of Buerger Allen Exercise.

The data presented in Table 4 shows the Range, Mean, Standard deviation of ABI score in experimental and control group. The data shows that the mean and median of right ABI score of experimental group (0.95±0.30; 0.95) were higher than the mean right ABI score of control group (0.86±0.35; 0.86). The mean left ABI score of experimental group (0.94±0.38; 0.95) was higher than the mean left ABI score of control group (0.85±0.04; 0.85).

Table 4: Range, Mean, Standard deviation of ABI score after administration of Buerger Allen Exercise in Experimental and Control Group N=60

Variables	Group	Range	Mean± SD	Median
Right ABI	Experimental group	0.84-1.0	0.95± 0.30	0.95
	Control group	0.79-0.92	0.86± 0.35	0.86
Left ABI	Experimental group	0.80-1.0	0.94± 0.38	0.95
	Control group	0.72-0.92	0.85± 0.04	0.85
Minimum score = 0.72		Maximum score = 1		

Table shows that mean and median of ABI score of experimental group was higher compared to control group.

Table 5: Mean, Mean difference, Standard Error of Mean difference and 't' value of ABI score of Experimental and Control Group after administration of Buerger Allen Exercise N=60

Variables	Group	Mean	M_D	SE_{MD}	t value	df	P-value
Right ABI	Experimental Group	0.95	0.08	0.008	10.18	58	**0.001*** **
	Control Group	0.86					
Left ABI	Experimental Group	0.94	0.09	0.01	8.46	58	**0.001*** **
	Control Group	0.85					
*****Very Highly Significant (p≤0.001)**			**'t' (58)=1.67**				

The data presented in Table 5 shows the Right ABI score after administration of Buerger Allen Exercise in experimental group (Mean =0.95), is higher than control group (Mean=0.86) and the left ABI score after administration of Buerger Allen Exercise in experimental group (Mean=0.94), is higher than control group (Mean=0.85). Independent 't' test was applied and computed 't' value obtained for both right ABI and left ABI was found to be statistically very highly significant (p=0.001) at 0.05 level. This showed that there was a significant difference in mean ABI Score of patients in experimental and control group. This reveals that the mean difference in ABI scores between experimental and control group was a true difference but not by chance. It was concluded that the Buerger Allen Exercise is an effective intervention in improving the foot perfusion in terms of ABI score among patients with Diabetes Mellitus.

Table 6: Chi-Square showing Comparison of Experimental and Control Group in terms of CRT after administration of Buerger Allen Exercise N=60

Sr. No.	Selected variables	Experimental Group (n=30) f(%)	Control Group (n=30) f(%)	Chi square (χ^2)	d.f.	p value
1	**CRT Right (Great toe)**					
1.1	<2 sec	27 (90.00)	07 (23.3)	27.14	01	**0.001*** **
1.2	>2 sec	03 (10.00)	23 (76.7)			
2	**CRT Left (Great toe)**					
2.1	<2 sec	27 (90.00)	05 (16.7)	32.41	01	**0.001*** **
2.2	>2 sec	03 (10.00)	25 (83.3)			
***Very Highly Significant (p≤0.001)		χ^2 (1)=3.84				

The data presented in Table 6 shows the capillary refill time of patients after administration of Buerger Allen Exercise in experimental group and control group. It depicts that the majority of the patients in experimental group (90%) were having right capillary refill time <2 seconds and in control group, majority (76.7%) were having right capillary refill time >2 seconds. And most of the patients in experimental group (90%) were having left capillary refill time <2 seconds and in control group majority (83.3%) were having left capillary refill time >2 seconds.

Chi square was computed to determine the effectiveness of experimental and control group in terms of capillary refill time after administration of Buerger Allen Exercise. The findings shows that both groups were different with respect to right capillary refill time (χ^2= 27.14, p=0.001) that was found statistically very highly significant (p=0.001) at 0.05 level. This showed that there was a significant difference in capillary refill time of patients in experimental and control group. This reveals that the CRT between experimental and control group was a true difference but not by chance. Hence, the null hypothesis (H_{02}) was rejected and the research hypothesis (H_2) was accepted. It can be inferred that the Buerger Allen Exercise is an effective intervention in improving the foot perfusion in terms of capillary refill time among patients with Diabetes Mellitus.

DISCUSSION

The present study findings revealed that a significant percentage of the Diabetes mellitus patients were 50-65 years of age (63.3%, 53.3%) both in control and experimental group. This findings was supported with the research done by Davis JA (2011), the rate of diagnosed diabetes among people aged 65±74 (21.8%) was more than 13 times that of people younger than 45 years of age (1.6%). [7] This finding is consistent with Gianna M Rodrighuer in which patients mean age was 54 (±12) years. [Error! Reference source not found.]

In the present study, more than half of the patients i.e. 37/60 (61.66%) were female. This was inconsistent with the study done by Fitchett G which found that, the rate for males began to increase at a faster rate than that of females. From 1980 to 2011, the age-adjusted rate of diagnosed diabetes mellitus increased 156% (from 2.7% to 6.9%) for males and 103% (from 2.9% to 5.9%) for females. [7]

In the present study, 33/60 (55%) patients were having duration of illness between 0-5 years, 24/60 (40%) patients were having duration of illness between 6-10 years and 3/60 (5%) patients were having duration of illness between 11-15 years. This finding is consistent with Gianna M Rodrighuer in which duration of diabetes was 10 (±8) years. [2]

The present study shows that 30/60 (50%) patients were suffering from comorbid illness in which 17/30 (56.6%) were suffering from hypertension, 8/30 (26.6%) were suffering from Chronic Kidney Disease (CKD), 1/30 (3.33%) was suffering from CVA, 04/30 (13.3%) were suffering from CAD, and 30/60 (50%) of patients were not suffering from any comorbid illness.

In the present study, 04/60 (6.66%) patients were underweight having body mass index <18.5, 45/60 (75%) patients

were having normal body mass index (18.5-24.9) and 11/60 (18.33%) patients were overweight (25-29.9).

In the present study, 11/60 (18.33%) patients were used to walk for <15 minutes per day, 24/60 (40%) patients used to walk for 15-30 minutes per day and 25/60 (41.66%) patients used to walk for >30 minutes per day.

The present study shows that 01/60 (1.66%) patient was having haemoglobin <7 gm/dl, 14/60 (23.3%) patients were having haemoglobin between 7-9 gm/dl, 14/60 (23.3%) patients were having haemoglobin between 9-11 gm/dl, and 31/60 (51.6%) patients were having haemoglobin >11 gm/dl.

The present study shows that 12/60 (20%) patients were having pre hypertension, 14/60 (23.3%) patients were having stage 1 hypertension, 16/60 (26.6%) patients were having stage 2 hypertension, and 18/60 (30%) patients were having stage 3 hypertension. This finding is consistent with Gianna M Rodrighuer (p=0.019) was significant predictor of ABI <0.9. [2]

The mean right ABI score before administration of Buerger Allen Exercise in control group was 0.86 as compared to 0.84 in experimental group. The mean left ABI score before administration of Buerger Allen Exercise in control group was 0.86 as compared to 0.83 in experimental group. These findings are consistent with Lepantalo M, who reported the mean value of ABI as 0.824 with SD 0.0652 among 30 peoples with type 2 diabetes mellitus. [8]

The present study shows that the mean right ABI score after administration of 5 days of Buerger Allen Exercise in experimental group was higher (0.95) as compared to control group (0.86) and the mean left ABI score after administration of 5 days of Buerger Allen Exercise in experimental group was higher (0.94) as compared to control group (0.85). This finding is consistent with Priyan, after the 5 days of Buerger Allen Exercise, the post-test mean score ABI was higher (0.88) than the pretest ABI score (0.73). [9]

The present study shows that before administration of Buerger Allen Exercise, majority of patients in experimental group (83.3%) had right CRT >2 seconds as compared to control group in which 73.3% had right CRT >2 seconds. Majority of patients in experimental group (90%) had left CRT >2 seconds as compared to control group in which 80% had left CRT >2 seconds.

After administration of Buerger Allen Exercise, majority of patients in experimental group (90%) had right CRT <2 seconds as compared to control group in which only 23.7% had right CRT <2 seconds. Majority of patients in experimental group (90%) had left CRT <2 seconds as compared to control group in which only 16.7% had left CRT <2 seconds. This finding is consistent with Gianna M Rodrighuer in which 17% patients have capillary refill time <2 seconds. [2]

In the present study there is no significant association of age, duration of diabetes mellitus with the ABI score**.** These findings are inconsistent with the study conducted by Edward B, in which the ABI results are associated with age (p=0.26, p=0.03), DM duration (p=0.28, p=0.02) and systolic and diastolic blood pressure (p=0.28, P=0.02; respectively). [10]

CONCLUSION

Buerger Allen Exercise is an effective strategy to improve the foot perfusion of patients with Diabetes Mellitus in terms of ABI score and CRT. Therefore, it is recommended that the 'Buerger Allen Exercise' can be administered to improve the foot perfusion of patients diagnosed with diabetes mellitus.

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