Effect of Buerger- Allen Exercise on Lower Extremities Perfusion among Patients with Type 2 Diabetes Mellitus

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ABSTRACT

Background: Diabetes mellitus has increased the risk of more complications. One complication that often occurs is peripheral vascular diseases and decreased foot perfusion of patients by causing endothelial and smooth muscle cell dysfunction in peripheral arteries. Buerger's exercise is a simple intervention for improving the peripheral circulation of patients with Diabetes mellitus. Therefore, **Aim of the study** was to evaluate the effect of Buerger-Allen Exercise on improving lower extremities perfusion among patients with type 2 Diabetes Mellitus. **Study design:** A quasi-experimental design was utilized to achieve the aim. **Setting:** This study was conducted at medical words affiliated to Ain Shams University Hospital; Egypt. **Sample:** A Purposive sample of 70 patients. **Procedure:** data were collected using three tools as follow:1-Structured Interview Questionnaire, 2- patient's medical history and clinical variables tool and 3- Peripheral Circulation Assessment Tools. **Results:** there was no statistically significant difference between pre intervention and post 1 mean score in right leg (t= 1.088, p= 0.278), while the score of the left leg showed a statistically significant difference (t= 3.699, p= 0.002). Also, there were a statistically significant differences between post 1 and post 2 after Buerger- Allen exercise implementation mean scores in both legs (t= 2.756, p= 0.007& t= 3.699, p= 0.002), respectively. This shows that Buerger Allen Exercise was effective in improving lower extremities perfusion. **The Conclusion**: Buerger Allen Exercise implementation is effective method for decreasing capillary refill time, increasing ankle brachial index (ABI) score and improving peripheral pulses, temperature, skin color and sensation post Buerger-Allen exercise implementation, which improving the lower extremities perfusion among patients with type 2 Diabetes Mellitus, which supported our research hypothesis. **Recommendation**: Encourage health care providers especially nurses to integrate Buerger Allen exercise in the care protocols of patients with DM in different health care settings.

Key words: Buerger Allen Exercise, lower extremities perfusion, type 2 Diabetes Mellitus.

Introduction

Diabetes mellitus (DM) is a disease that occurs when the pancreas does not produce enough insulin, or when the body cannot effectively use the insulin it produces. Type 2 diabetes is mostly a broadminded disorder defined by insufficiencies in insulin excretion and activity that leads to nonstandard glucose metabolism and interrelated metabolic imbalances. uncontrolled diabetes can cause serious complications include those that are macro vascular – for example, cardiovascular disease – and those that are micro vascular – including nephropathy, retinopathy, neuropathy and erectile dysfunction **(Milne & Di Rosa, 2019 & Mukhtar, et al 2020).**

Diabetes increases the risk of lower extremity amputations because of deficit in diabetic management and care that result in infected, non-healing foot ulcers. Among all other complications, peripheral neuropathy is a well-known micro vascular complications causing chronic hyperglycemia which results in sensory loss and damage causing lower extremity amputations (**Radhika**, **et al 2020).**

Peripheral arterial disease is a condition characterized by atherosclerotic occlusive disease of the lower extremities and gradual decrease in blood flow to one or more limbs secondary to atherosclerosis. The risk of Peripheral Vascular Disease (PVD) is increased in patients who are complains of diabetes mellitus, occurs earlier and is often more

severe and diffuse **(Lazzarini, et al 2018)**. PVD most commonly affects the legs, but other arteries may also, included leg pain when walking which resolves with rest, known as intermittent claudicating is considered the classic symptom. The other symptoms including cold skin, skin ulcers, bluish skin, or poor nail and hair growth in the affected leg. Complications also, include an infection or tissue death which may require amputation. While peripheral arterial disease is a major risk factor for lower-extremity amputation, it is also, accompanied by a high risk for symptomatic cardiovascular and cerebrovascular disease (**Kumari, et al 2019&Kim, et al 2021).**

Perfusion is the passageway of fluid over the circulatory system or lymphatic system to an organ or tissue; it also, denotes to the transport of blood to capillaries in tissue. Heart tissue is considered over perfusion because they normally are receiving more blood than rest of tissue in organism; they need this blood because they are constantly working **(Suza, et al, 2020).** Diabetes causes serous and extensive changes in the vascular system, increasing the risk of developing atherosclerosis (large and medium-sized arteries) and causing a specific lesion in microcirculation (small vessels). Hyperglycemia causing excess production of reactive oxygen species that destroy and interfere with the normal endothelial functions. **(Bhuvaneshwari & Tamilselvi, 2018)**

Buerger-Allen Exercise (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 and it is one of the interventions to stimulate the development of collateral circulation in the legs. Also, is one of the most common practice used for patient with diabetes to drain engorged vessel. It is performed to promote Lower Extremity Perfusion (LEP) by using postural changes and stimulated peripheral circulation by modulating gravity and applying muscle contraction for improving the lower extremity perfusion. Additionally, encouraging the wound healing process and decrease Peripheral Neuropathy Symptoms (PNS) among patients with Diabetes Mellitus (DM) **(Hassan, et. al 2020).**

Nurses do very crucial role in improving lower limb perfusion among patients with type 2 Diabetes mellitus. Buerger Allen exercise is simple to implement without any danger and costs, the evident proof that Buerger Allen exercise advances the lower extremity perfusion **(Nair, 2019)**. So, the nurse should focus on prevention of complications by screening high-risk people, early recognition and prevention of PAD to those at increased risk. An awareness of diagnostic and treatment strategies will enable the nurse to educate patients and providing health care. This will benefit to develop both compatible with treatment and disease outcome **(Tawabini, 2020).**

Significance of the study:

Diabetes is the commonest metabolic disorder that affects populations in the entire world. The incidence of diabetes is affected by genetic, ethnic and socioeconomic factors. In 2019, an appraised 1.5 million deaths were straight produced by diabetes. About 422 million adults are living with diabetes mellitus, people worldwide have diabetes, the majority living in low-and middle-income countries, and 1.6 million deaths are directly attributed to diabetes each year. Both the number of cases and the prevalence of diabetes have been steadily increasing over the past few decades **(WHO, 2020)**. By 2045, forecasts display this number increasing to some 700 million diabetics globally **(John Elfelin, 2021)**. Type 2 diabetes affected about 85-90% of all cases. In Egypt, diabetes mellitus is rapidly growing public health problem with a significant effect on morbidity, mortality, and health care resources. Currently, the prevalence of type II diabetes (T2D) is around 15.6% of diabetic Egyptian adults aged twenty (20) to seventy-nine (79) years of age **(Khan & Hamdy, 2017 & Hassan, et al 2020).**

Individuals with diabetes mellitus have a two to fourfold increase in the risk of developing peripheral arterial disease. Diabetes mellitus increases the risk of lower extremities circulation impairment this leads to sever complications like foot ulcer and gangrene in the lower limbs because of neuropathy, vascular insufficiency, and impaired wound healing leading to lower limb amputation.

Diabetic foot is a major cause of disability, reduced quality of life, prolonged hospitalization, financial loss, lower limb amputation, and increase mortality rate. Several researches support the positive effect of Buerger- Allen exercise in patients with type 2 Diabetes**.** So, our study aimed to evaluate the effect of Buerger- Allen exercise on lower extremities perfusion among patients with type 2 Diabetes Mellitus.

Aim of the Study:

The aim of the current study was to evaluate the effect of Buerger-Allen Exercise implementation on lower extremities perfusion among patients with type 2 Diabetes Mellitus.

Research Hypotheses

H 1. Patients who performed Buerger-Allen exercise will have decreasing in capillary refill time post Buerger-Allen exercise implementation.

H 2. Patients who performed Buerger-Allen exercise will have increasing in ankle brachial index (ABI) score post Buerger-Allen exercise implementation.

H 3. Patients who performed Buerger-Allen exercise will have improvement in peripheral pulses, Temperature, skin color and sensation in lower extremities post Buerger-Allen exercise implementation.

Subjects and Methods

A- Research design:

One group quasi experimental interrupted time series design was used in this study. This design is one of the experimental designs in which data are collected from research subjects both before and after introducing the experimental intervention and it is also called an interrupted time series design. In addition to the pre-test and immediate post-test, a delayed posttest or posttests are often included to examine the effects of the treatment over the longer term **(Rogers & Révész, 2020)**.

B- Setting:

The study was conducted at medical departments affiliated to Ain Shams University Hospital; Egypt. Each department is divided into four rooms (male & female), every room has 20 beds for patients with different medical diagnosis.

C- Subject:

A Purposive non probability/non randomized sample of adult patients with type 2 DM for a period of six months from the beginning of May 2020 to the end of November 2020, who fulfill the inclusion criteria.

Inclusion criteria:

1. Adult both gender male/female.

2. Willing to participate in study.

3. Never received the same intervention from other researchers and health professionals.

Exclusion criteria:

1. Diagnosed with foot ulcer or foot gangrene.

2. Critically ill.

3. Suffering from any vascular diseases.

D-Tools of data collection

1. Structured Interview Patient Questionnaire: to collect patient characteristics as: age, gender, education, dietary pattern, type of activities, BMI and habits.

2. Patient's medical history and clinical variables tool: This tool was written in English language after reviewing the recent and relevant literature (**Hassan, et al 2020 & Radhika**, **et al 2020)** to collect health related variables as: duration of diabetes mellitus, associated illness, diabetes treatment, History of leg cramps, received medical treatment for peripheral arterial diseases (PAD), nail condition, family's history with DM, Family history of PAD and eight questions related to sensation, asked about symptoms related to Diabetic Peripheral Neuropathy (DPN); as feeling of numbness, tingling, burning, crawling of insects, sensitive to touch, hot/cold water, open sore or hurt during walking; the answer were either yes or No, the presence of feeling for each question was (1) and not present of feeling was (0).

3. Peripheral Circulation Assessment Tools:

Part I: It was concerned with assessment of patients' grades of Lower extremities perfusion contains six parameters as peripheral pulses, Capillary refill Time, edema, Temperature, pain and skin color; with four responses ranged from normal (0), mild (1), moderate (2), sever (3), adopted from **Priya, (2016)** to assess peripheral pulses (posterior tibial & dorsalis pedis), Capillary refill Time (1-2 sec., 3 sec., 4 sec. & >4 sec.), presence of edema (No edema, (+1) < 2 mm pitting that disappeared rabidly, (+2) 2 to < 4 mm pitting that disappeared in 10-15 sec. & (+3) 4 to < 6 mm pitting that disappeared in 10-15 sec.), Temperature (Warm, Mild, Moderate & Cold), pain (No pain, Mild, Moderate & Sever) and skin color (pink, Pale, Cyanosis /Black &Reddish). The total Scoring was as following:

Grades	Score	Interpretation
1	0-4	Adequate perfusion (good blood circulation)
2	5-9	slightly inadequate perfusion (slightly poor blood circulation)
3	10-14	Inadequate perfusion (poor blood circulation)
4	15-18	Severely inadequate perfusion (very poor blood circulation)

Part II: Ankle Brachial Index (ABI) scale adopted from **Zahran, et al. (2018)** to calculate the perfusion of lower limbs right and left. The manual Ankle-Brachial Index (ABI) was performed by a researcher using standard manual sphygmomanometer for the measurement of lower extremity pressure (LEP). For calculating the ABI, each ankle systolic pressure was distributed by the brachial systolic pressure and the greater of the two systolic pressures for each leg was distributed by the greater of the two arm pressures to acquire the right and left ABI based on the following equation:

$$\text{Ankle-Brachial Index} = \frac{\text{Highest ankle pressure}}{\text{Highest brachial arm pressure}}$$

The score was inferred as

Score	Interpretation
above 0.9	Normal perfusion
0.71–0.90	Mildly diminished perfusion
0.41–0.70	Moderately diminished perfusion
0 -0.40	Severely diminished perfusion

Educational guidelines booklet

Developed by the researchers written in Arabic language guided by images, based on the results obtained from assessment of the patients, as well as reviewing the recent and relevant literature (**Kumari et al., 2019 & Walking, et al., 2021**). The booklet was handed out for every patient; composed of 4 parts as follow: **Part (1):** Introduction about diabetes mellitus, causes, complication & treatment**. Part (2):** foot problems of patients with DM & its management. **Part (3):** Allen burger exercises definition, technique and benefits. **& Part (4):** General exercises for foot care of patients with DM.

The educational guidelines were revised by five experts 4 professors of Medical Surgical Nursing as well as 1 professor of internal medicine, at Ain Shams University for content validity. Based on the opinion of a panel of expertise some modifications were done, and then the final form was developed.

Tools validity and reliability

Validity: assessing face and content validity of the suggested tools through a jury of five experts 4 professors of Medical Surgical Nursing as well as 1 professor of internal medicine, who reviewed the instrument, for clarity, relevance, comprehensiveness, understanding, and easiness for administration, no modifications were required.

Reliability: Alpha Cronbach test was used to measure the internal consistency of the study tools. In which Peripheral Circulation Assessment Tool part 1; assessment of patients' grades of Lower extremities perfusion test was reliable at (0.897) and part 2; Ankle Brachial Index (ABI) scale test was reliable at (0.87).

Preparatory phase:

Administrative design: The necessary official approvals were obtained from the administrators of the Ain Shams University Hospital. Letters of request were issued to them from the Faculty of Nursing at Ain Shams University explaining aim of the study and its expected outcomes.

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Preparatory phase:

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Ethical considerations: In order to protect patients' rights in scope of the study, before the initial interview, a verbal consent was secured from each patient after being informed about the nature, purpose and benefits of the study. Patients were also, informed that participation is entirely voluntary and could withdraw at any time without giving reasons. Confidentiality and anonymity of the data was assured by stating that the personal information will be saved private after being united with the researchers and comforted patients that the data would be recycled only for the research objective. Moreover, the intervention used in the current study is safe and not causing any harm to participants.

Pilot Study:

Once permission was granted to proceed with the proposed study, a pilot study was carried out before starting data collection on 7 of targeted patients from the previously mentioned setting according to the inclusion criteria and excluded from the main sample to evaluate feasibility, the clarity, applicability of the tools, and calculate the time needed to collect data to detect any potential hindrances that might meet the researchers and restrict with data collection.

The study analysis of feasibility revealed that the patient's level of lower extremities perfusion was different before and after Buerger- Allen Exercise. A pilot study also revealed that 15minutes repeated for 5-6 timesof Buerger- Allen Exercise were convenient for improving sensation in lower extremities as verbalized by patients.

I- Implementation phase

Field work: The study was carried out from the beginning of May 2020 to November 2020, including development of the tools. It was based on reviewing recent and relevant literature regarding Buerger- Allen exercise, lower extremities perfusion, and type 2 Diabetes Mellitus. The researchers were visiting the medical departments in the morning and afternoon shifts for ٣-days/week. Aim of the study was purely clarified to patients who approved to participate in the study prior to data collection. Data collection was done by the researchers using the same tools for the same patient who fulfilled inclusion criteria; before and after the intervention (performing Buerger- Allen exercise).

The baseline assessment: The first time; individualized interview session was conducted to each participant by the researchers to collect demographic data, medical history &clinical variables and peripheral circulation assessment of both lower extremities. The researcher also clarified to the participants that the peripheral circulation assessment would be assessed at three times. The first time for measurement their perfusion level without any intervention (1st measurement).

The researchers demonstrated Buerger-Allen exercise for every patient individually with relative on the same day;5-6 times/ day for 12-15 minutes' duration continued for 15 days, using supported educational booklet and videotape beside hospital routine care.

The researchers demonstrated the Buerger-Allen exercise as an intervention to improve

circulation to the feet and legs, encourage participants to re-demonstrate the following three steps and informed them that Buerger-Allen exercise must be performed 5-6 times per day.

Step 1- Elevation

The lower extremities are raised to 45-degree angle and maintained in this position till the skin blanches (3-5 minutes).

Step 2- Dependency

The feet and legs are then dropped below the level of the rest of the body till redness seems (3-5 minutes).

Step 3- Horizontal

The legs are located flat on the bed for 5 minutes with exercising the feet and ankle joint by demonstration of dorsi flexion, planter flexion and rotation. The length of time for each position varied with the patient's tolerance and color change occurs. Usually the exercise is prescribed for about 12-15 minutes repeated for 5-6 times/day/15 days under supervision of the researchers and relatives **(Latha, et. al 2019; Hassan, et. al 2020 & Suza, 2020)**.

Evaluation phase:

This phase started immediately after the proposed intervention was implemented for each patient, the researchers assessed effect of Buerger-Allen exercise on patients peripheral circulation level of the lower extremities by comparing the results pre, post1 and post 2,the 2nd measurement (post1) on the fifth day of administering Buerger-Allen exerciseby using Peripheral Circulation Assessment Tool, after the first intervention then the 3rd measurement (post 2) after 15 days from baseline reading, in case of patient discharged in short time length of stay in the hospital before finishing the scheduled times of intervention and evaluation, the researchers done evaluation in his first follow up visit after discharged and contact patients by their telephone numbers to determine the other appointments in order to complete data collection process.

Statistical Design:

The data was coded and entered using a personal computer. Statistical Package for Social Science (SPSS) version 20 was utilized. Data were obtainable using descriptive statistics in the form of frequencies and percentages. T-test was utilized as an inferential statistic was used to investigate the effect of Buerger-Allen exercise on the changes in level of lower extremities perfusion at three times: pre intervention, post (1), and post (2) intervention scores. The chi-square test was used to identify the relationship between qualitative variables and Mean±SD also was used. Statistical significance was considered at p-value $\leq$ 0.05, and < 0.001 was considered highly significant.

Results

Table (1): Number and percentage distribution of the studied subjects' characteristics (N=70)

Patients Characteristics	Number & percentage	
	N	%
Age		
30 < 41	7	10
41 < 51	24	34.3
51- 60	16	22.9
above 60	23	32.8
Mean±SD	54.72±6.48	
Gender		
Male	32	45.7
Female	38	54.3
Education Level		
can't read or write	14	20.0
primary education	18	25.7
Secondary education	0	0.0
High education	38	54.3
Dietary pattern		
Vegetarian	16	22.9
not vegetarian	54	77.1
BMI		
normal (18.5-24.9kg/m2)	18	25.7
over weight (25-29.9 kg/m2)	37	52.9
class I obesity (30-34.9 kg/m2)	10	14.3
class II obesity (35-39.9 kg/m2)	5	7.1
Mean±SD	28.6±5.12	
Type of activities		
Sedentary work	37	52.8
Moderate work	23	32.9
Heavy work	10	14.3
Habits		
Smoking	14	20.0
Alcohol	5	7.1
None	51	72.9

Table 1 showed that, 34.3% of the studied subjects were aged between 41 < 51 years, the mean age of them 54.72 (*SD* 6.48) years. As regard to gender and education level 54.3% of the studied patients were female and high educated. Also, 77.1% of them not vegetarian. Moreover, 52.9% of the studied patients were overweight, the mean weight of them 28.6 (*SD* 5.12) kg/m2 and do sedentary work. In relation to special habits of patients under study, it was found that 72.9% of them do not smoke or drink alcohol.

Table (2): Number and percentage distribution of the studied subjects' medical history and clinical variables (N=**70**)

Medical History and Clinical Variables	Number & percentage	
	N	%
Duration of Diabetes mellitus		
Less than 5 years	28	40.0
5 – 10 years	25	35.7
More than 10 years	17	24.3
Associated illness **Hypertension**		
Yes	39	55.7
No	31	44.3
Cardiac problems		
Yes	21	30.0
No	49	70.0
Renal problems		
Yes	15	21.4
No	55	78.6
Diabetes treatment		
Oral hypoglycemic agents	42	60.0
Insulin	20	28.6
Insulin and oral hypoglycemic agents	8	11.4
History of leg cramps:		
Yes	59	84.3
No	11	15.7
Receive medical treatment for PAD		
Yes	7	10.0
No	63	90.0
Nail condition		
Normal	36	51.4
unkempt and ragged	13	18.6
Thickened	21	30.0
Family history of peripheral artery disease		
Yes	20	28.6
No	50	71.4
Family's history with DM		
Yes	45	64.3
No	25	35.7

Table 2 showed that 40% of the studied subjects diagnosed with diabetes mellitus from less than 5 years and 55.7% of them having hypertension. As regard to type of diabetes treatment and receive medical treatment for peripheral artery disease, 60% and 90% of the studied patients were receiving oral hypoglycemic agents and do not receive medical treatment for PAD, respectively. Also, 84.3% of them reported history of leg cramps. According to nail condition 51.4% had normal nails. Moreover, 28.6% and 64.3% of the studied patients had Family history of PAD and diabetes mellitus, respectively.
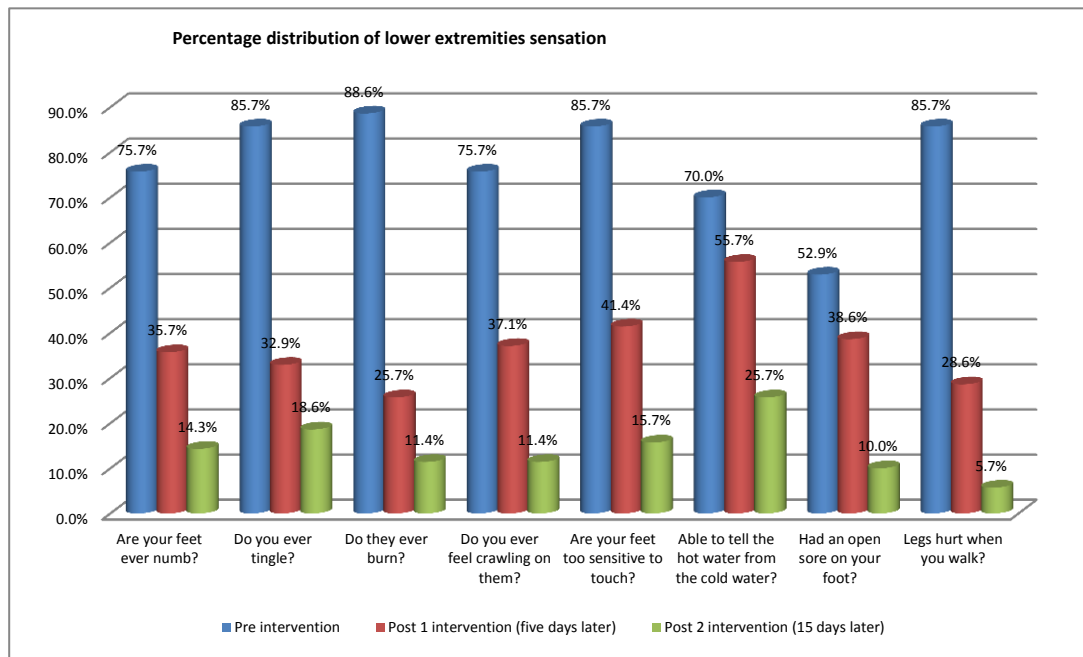

Figure (1): Percentage distribution of lower extremities sensation among the studied subjects (N=**70**)

Figure 1 illustrates the percentage distribution of lower extremities sensation during the three measurements. It was noted that patients had history of diabetic neuropathy feeling/sensation in lower extremities related to feeling of numbness, tingling, burning, crawling, sensitivity to touch, sensitivity to water, open sore and hurting during walking 75.7%,85.7%, 88.6%, 75.7%, 85.7%, 70.0%, 52.9% & 85.7%, respectively. The feeling of lower extremities improved after 1st intervention as 35.7%,32.9%,25.7%,37.1%,41.4%,55.7%,38.6% & 28.6%, respectively, of patients display feeling in lower extremities that decreased to 14.3%, 18.6%, 11.4%, 11.4%, 15.7%, 25.7%, 10.0% & 5.7%, respectively, after 2nd intervention.

Table (3): Number and percentage distribution of pre and post intervention scores among studied subjects of lower extremities perfusion in Right leg (N=**70**)

Perfusion of Right leg	Pre intervention		Post 1 intervention (five days later)		Post 2 intervention (15 days later)		Pre & post1 χ2	Pre & post2 χ2	post1 & post2 χ2
	N	%	N	%	N	%	[p-value]	[p-value]	[p-value]
Adequate perfusion	11	15.7	20	28.6	24	34.3	9.808 [0.020*]		
slightly inadequate perfusion	26	37.2	32	45.7	42	60.0		31.533 [<0.001*]	10.624 [0.005*]
Inadequate perfusion	29	41.4	18	25.7	4	5.7			
Severely inadequate perfusion	4	5.7	0	0.0	0	0.0			

*Significant at $p < 0.05$

Table 3 shown that there was statistically significant relation regarding total Level of perfusion at Right leg pre, post 1; pre, post 2 and post 1, post 2 of the Burger- Allen Exercise implantation at p-value <0.05.

Table (4): Number and percentage distribution of pre and post intervention scores among studied subjects of lower extremities perfusion in left leg (N=**70**)

Perfusion of left leg	Pre intervention		Post 1 intervention (five days later)		Post 2 intervention (15 days later)		Pre &post1 χ2	Pre &post2 χ2	post1 &post2 χ2
	N	%	N	%	N	%	[p-value]	[p-value]	[p-value]
Adequate perfusion	13	18.6	23	32.8	25	35.7			
slightly inadequate perfusion	22	31.4	30	42.9	43	61.4	12.604 [0.006*]	40.074 [<0.001*]	14.241 [<0.001*]
Inadequate perfusion	30	42.9	17	24.3	2	2.9			
Severely inadequate perfusion	5	7.1	0	0	0	0.0			

*Significant at p < 0.05   *Highly Significant at P< 0.001*

Table 4 indicated that there was statistically significant relation regarding perfusion at left leg between pre and post 1 of Buerger- Allen Exercise implementation at p-value <0.05. Also, there were highly statistically significant relation between pre, post2 and post 1, post 2 after Buerger- Allen Exercise implementation at p-value <0.001.

Table (5): Comparison between pre and post intervention of lower extremities perfusion score in Right and left legs among studied subjects (N=**70**)

Perfusion of lower extremities	Pre intervention		Post 1 intervention (five days later)		Post 2 intervention (15 days later)		Pre & post 1 t	Pre &post 2 t	post1 &post 2 t
	Mean	SD	Mean	SD	Mean	SD	[p-value]	[p-value]	[p-value]
Right	9.00	4.49	7.79	8.15	4.70	3.32	1.088 [0.278]	6.441 [<0.001*]	2.938 [0.004*]
Left	9.17	4.50	6.56	3.82	5.00	2.80	3.699 [0.002*]	6.582 [<0.001*]	2.756 [0.007*]

*Significant at p < 0.05   *Highly Significant at p P< 0.001*

Table 5 illustrated that there was no statistically significant relation between pre and post 1 mean score in right leg (t= 1.088, p= 0.278), while the score left leg showed a statistically significant relation (t= 3.699, p= 0.002), while there was a highly statistically significant relation between pre and post 2 in both legs at p<0.001.   Also, there were statistically significant relation between post 1 and post 2 after Buerger- Allen exercise implementation means scores in both legs (t= 2.756, p= 0.007& t= 3.699, p= 0.002), respectively. This shows that Buerger Allen Exercise implementation is effective in improving lower extremities perfusion.

Table (6): Comparison between the patients' peripheral pulses, Capillary Refill and ABI pre, post1 and post 2 of Buerger- Allen exercise implementation in Right and left legs among studied subjects (N=70)

Level of perfusion		Pre		Post1		Post2			Pre &post1 χ2 [p-value]	Pre & post 2 χ2 [p-value]	post1 & post 2 χ2 [p-value]
		N	%	N	%	N		%			
Rt Leg	**Post. Tibial**										
	Normal	23	32.9	28	40.0	51		72.9	0.771	22.473	15.368
	Impaired	47	67.1	42	60.0	19		27.1	[0.380)	[<0.001*]	[<0.001*]
	Dors. Pedis										
	Normal	20	28.6	25	35.7	50		71.4	0.819	25.714	17.949
	Impaired	50	71.4	45	64.3	20		28.6	[0.366]	[<0.001*]	[<0.001*]
	Capillary Refill										
	Normal	11	15.7	34	48.6	57		81.4	17.342	60.507	16.609
	Impaired	59	84.3	36	51.4	13		18.6	[<0.001*]	[<0.001*]	[<0.001*)
	Ankle Brachial Index (ABI)										
	Normal	4	5.7	14	20.0	49		70.0			
	Impaired	25	35.7	28	40.0	14		20.0	8.236	65.868	37.434
	Moderate	36	51.4	24	34.3	7		10.0	(0.041*]	[<0.001*]	[<0.001*]
	Sever	5	7.1	4	5.7	0		0.0			
Lt Leg	**Post. Tibial**										
	Normal	18	25.7	24	34.3	54		77.1	1.224	37.059	26.055
	Impaired	52	74.3	46	65.7	16		22.9	[0.268]	[<0.001*]	[<0.001*]
	Dors. Pedis										
	Normal	15	21.4	18	25.7	49		70.0	0.357	33.273	27.508
	Impaired	55	78.6	52	74.3	21		30.0	[0.550]	[<0.001*)	[<0.001*)
	Capillary Refill										
	Normal	7	10.0	36	51.4	62		88.6	28.228	86.446	22.993
	Impaired	63	90.0	34	48.6	8		11.4	[<0.001*]	[<0.001*]	[<0.001*]
	Ankle Brachial Index (ABI)										
	Normal	8	11.4	18	25.7	53		75.7			
	Impaired	39	55.7	27	38.6	11		15.7	6.806	60.422	36.529
	Moderate	16	22.9	20	28.6	6		8.6	[0.078]	[<0.001*]	[<0.001*]
	Sever	7	10.0	5	7.1	0		0.0			

Highly Significant at P< 0.001

Table 6 showed that, regarding posterior tibial and dorsalis pedis pulses there were no statistically significant relation between pre and post 1 in both legs (p= 0.380, 0.366, 0.268 & 0.550) respectively, while there was highly statistically significant relation between pre, post 2 and post1, post 2 in both legs at p<0.001. As regard capillary refill, there were highly statistically significant relation between pre, post 1; pre, post 2 and post 1, post 2 in both legs at p<0.001. The same was applied to ABI there was statistically significant relation between pre and post 1 in right leg (p= 0.041), while there was no statistically significant relation in left leg (p= 0.078). There was highly statistically significant relation between pre, post 2 and post 1, post 2 in both legs at p<0.001 after Buerger- Allen exercise implementation.

Table (7): Relation Between post test scores of total lower extremities perfusion and Selected studied subjects' characteristics among study sample (N=70)

Post 1 intervention (five days later)	perfusion of lower extremities			Chi-square	
	Adequate perfusion	slightly inadequate perfusion	Inadequate perfusion		
	N	N	N	X^2	P-value
Age					
30 < 41	1	4	2		
41 < 51	7	5	12	8.871	0.181
51- 60	5	3	8		
above 60	3	12	8		
Gender					
Male	7	11	14		
Female	9	13	16	0.036	0.982
BMI					
normal (18.5-24.9kg/m2)	11	5	2		
over weight (25-29.9 kg/m2)	4	14	19	22.083	<0.001*
class I obesity (30-34.9 kg/m2)	1	3	6		
class II obesity (35-39.9 kg/m2)	0	2	3		
Duration of Diabetes mellitus					
Less than 5 years	9	17	2		
5 – 10 years	4	5	16	25.471	<0.001*
More than 10 years	3	2	12		
Diabetes treatment					
Oral hypoglycemic agents	11	15	16		
Insulin	2	9	9	6.802	0.147
Insulin and oral hypoglycemic agents	3	0	5		
Family history of peripheral artery disease					
Yes	7	7	6		
No	9	17	24	2.890	0.236
Receive medical treatment for PAD					
Yes	4	0	3		
No	12	24	27	6.667	0.036*

*Highly Significant at *p* P< 0.001

Table 7 revealed that there was a highly statistically significant relation between BMI, Duration of Diabetes mellitus and total lower extremities perfusion (p<0.001). Also, there was a statistically significant relation with Receive medical treatment for PAD (p= 0.036).

Table (8): Relation Between post test scores of lower extremities perfusion and sensation among studied subjects (N=70)

lower extremities sensation	Perfusion of lower extremities				
	Adequate	slightly	Inadequate	Chi-square	
	N	N	N	X^2	P-value
Are your feet ever numb?					
Yes	4	3	18	14.140	<0.001*
No	12	21	12		
Do you ever tingle?					
Yes	5	2	16	12.263	0.002*
No	11	22	14		
Do they ever burn?					
Yes	1	3	14	12.262	0.002*
No	15	21	16		
Do you ever feel crawling on them?					
Yes	2	5	19	15.710	<0.001*
No	14	19	11		
Are your feet too sensitive to touch?					
Yes	5	6	18	7.617	0.022*
No	11	18	12		
Able to tell the hot water from the cold water?					
Yes	12	7	20	10.726	0.005*
No	4	17	10		
Had an open sore on your foot?					
Yes	3	13	27	23.170	<0.001*
No	13	11	3		
Legs hurt when you walk?					
Yes	2	3	15	11.813	0.003*
No	14	21	15		

*Significant at $p < 0.05$

Table 8 showed that there was a statistically significant relation between post test scores of lower extremities perfusion and feeling/sensation of diabetic neuropathy (p<0.05). this table shows that Buerger Allen Exercise implementation is effective in improving lower extremities sensation related diabetic neuropathy.

Discussion

Peripheral vascular disease and diabetes are both increasingly prevalent conditions, affecting an estimated 200 and 360 million people worldwide, respectively **(Berger & Ladapo, 2017).** 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 which leads to grave complications like gangrene in the lower limbs. Buerger Allen Exercise is one of the interventions which stimulate the development of collateral circulation in the legs. The mechanism of Buerger's exercise use gravitational alterations in points that are applied to the soft musculature of vessels and the vascular. Gravity helps alternately to empty and to fill the blood columns, which can eventually increase transportation of blood through them **(Kumari, et al 2019).**

The present study revealed that mean average age among the studied subjects was (54.72 ± 6.48) years, this is related to increase the risk of peripheral arterial disease among type II diabetes mellitus with aging process, also more than half of them were females, with high education and were doing sedentary work and more than three quarters were have mixed dietary pattern (non-vegetarian), and nearly three quarters were nonsmokers & nonalcoholic.

The previously mentioned results were in agreement with **Sasi, et al (2020)** who revealed that, the average age of experimental group in their study of lower extremities perfusion with Type 2 Diabetes Mellitus was55.30 ± 4.58. This result was also in contradicted with **Bhuvaneshwari & Tamilselvi (2018)** who revealed that more than one third of the patients with diabetes age group were above 60 years old.

The result of this present study illustrated that more than half of the studied subjects were females, this can be discussed as decline level of estrogen at menopause cause increased risk for diabetes mellitus because estrogen produce several anti-aging effects including anti oxidative properties as oxidative stress is considered the most important cause in micro vascular diseases. This result agreed with **Suza, (2020)** who illustrated that more than half of the patients were females. In contrary to the current study findings **Hemalatha (2018)** who study effectiveness of buerger Allen exercise on lower extremities perfusion among patients with diabetes mellitus and mentioned that most of the sample were males.

The present study shows that more than half of the studied subjects are overweight whereas that less than one third have normal BMI this result is consistent with **El-Fattah, et al (2019),** who inferred that nearly two thirds of the patients with diabetes mellitus had B.M.I. of 23-27.4 (65%). In contrast to the current study results **Tawabini (2020),** who reported that, nearly half of the subjects were in the normal range of body mass index. This is due to that Increased BMI was associated with increased prevalence of diabetes mellitus. An increase in body fat is commonly related with increased risk of metabolic illnesses such as type II diabetes mellitus.

The current study showed that two-fifths of the studied subjects' duration of diabetes less than five years. This can be discussed as the duration of diabetes has no relation with susceptibility to peripheral arterial disease. This finding is in the same line with **Latha, et. al (2019)** who mentioned that, more than half of the studied sample was having duration of diabetes mellitus between zero to five years. Also, this result in disagreement with **Patidar**

(2018) who stated that less than two thirds of the study sample were having duration of diabetes from five years to ten years.

Regarding other associated illness, the current study revealed that more than half of the studied subjects were hypertensive while about three quarters were have no cardiac or renal illness this results is agreed with **Kumari, et al (2019)**who showed that (50%) patients were suffering from comorbid illness in which 56.6% were suffering from hypertension, (26.6%) were suffering from Chronic Kidney Disease, (3.33%) was suffering from CVA(13.3%) were suffering from CAD, and (50%) of patients were not suffering from any comorbid illness.

The present study revealed also that more than three quarters of the studied subjects were hasn't family history of peripheral arterial disease. Because the diabetes mellitus will be caused either by getting old, obese, not exercising regularly and not eating healthy food. This result was further supported by **Hemalatha (2018)** who found that the majority of studied patients weren't have family history of peripheral atrial disease.

Regarding the lower extremities, the current study revealed improvement in the feeling & sensation of the lower extremities after first and second Buerger Allen exercise implementation. This is relevant to the research of **Awaluddin, et al (2019),** who was stating that foot exercise affects the treatment of peripheral neuropathy as evidenced by a decrease in the average score of neuropathy among people with diabetes. The similar result also proved by research of **Zahran, et al (2018),** who mentioned that there is a significant effect of foot exercise on peripheral neuropathy. But on the other hand, based on a research conducted by **Matos, et al (2018)** who stated that performing physical activities such as foot exercises will emit stimulants that will help restore motor nerve function. However, it should in long period, at least 13 weeks due to nerve damage.

The current study illustrated that more than three quarters of the studied subjects have normal pulses, capillary refill, & Ankle-Brachial index (ABI) post intervention in both legs, also there were a statistically significant

relation in the lower extremities' perfusion between pre and post 1 &post 2 for both legs. This result is consistent with **Hidayati, et al (2021)** they conducted a significant improvement in the lower extremities perfusion after the Buerger Allen exercise in their study. This finding is congruent with **Thakur& Sharma (2019)** who shows that Buerger Allen Exercise is effective in improving lower extremities perfusion among patients. Also (**Radhika**, **et al 2020**) revealed that there is a significant improvement in (ABI) score in improving the level of lower extremities perfusion among people with DM after receiving Allen Buerger exercise at the level of P<0.05.

Also in a study of **Hafid, et al (2020)** which revealed that there is a significant improvement in Ankle-Brachial Index Score in preventing peripheral blood vessel illness among people with diabetes mellitus in experimental cluster once receiving Allen Buerger exercise at the level of P<0.05 and there is a significant relation between the extent duration of diabetes and the pretest score of ABI. Studied subjects got benefited by Allen Buerger exercise in preventing PAD.

Results of this study showed a highly statistically significant improvement in perfusion grad among the studied subjects. The researcher's purpose of read that, Buerger Allen exercise meant to enhance feet and legs circulation this may increase blood flow, in order that the sensation of pain will decrease. These results are congruent with **Digal, (2019)** who study impact of Buerger Allen exercise on lower extremities perfusion among patients with type 2 diabetes mellitus and demonstrated that comparison of pre and posttest findings showed that within the experimental group, the mean lower extremities perfusion was 0.84 which was over the mean in control group 0.67 with p=0.000.

Results of this study showed statistical significance relations among the studied subjects and their post assessment of the selected studied subjects' characteristics of peripheral vascular disease PVD relating to body mass index (BMI) once applied Beurger Allen exercise. As a result of the exercise steps were straightforward and the participants did

not need to make a great effort to do it, therefore those who have overweight were easy to exercise.

This result had been agreed with study by **Hemalatha (2018)** who showed that, the relation between post test scores based on checklist for selected clinical features of PVD was significant difference in body mass index (BMI). In contrast with the current study finding the study done by **Hassan, et. al (2020)** who revealed that the effectiveness of Buerger Allen Exercise on lower extremity perfusion and showed that, there was no association between post-test peripheral perfusion with selected variables such as patients with normal BMI.

The result of the current study revealed there were statistical significance relations among the studied subjects and their post assessment regarding lower extremities sensation post Beurger Allen exercise implementation. As well this finding also is in agreement with **Seferovic, et. al (2018)** who reported that sensation related questions provide additional prognostic information about the cardiovascular outcome in individuals with type 2 diabetes. This finding supported the research hypothesis that Patients who performed Buerger-Allen exercise had decreased in capillary refill time, increased in ankle brachial index (ABI) score and improved in peripheral pulses, temperature, skin color and sensation post Buerger-Allen exercise implementation, which improved lower extremities perfusion among patients with type 2 diabetes mellitus.

Conclusion

This study indicated that Buerger Allen Exercise implementation is effective technique for decreasing capillary refill time, increasing ankle brachial index (ABI) score and improving peripheral pulses, temperature, skin coloring and sensation post Buerger-Allen exercise implementation, that improving the lower extremities perfusion among patients with type 2 Diabetes Mellitus

Recommendations

Based on the finding of the present study, the researchers recommended the following.

- Encourage health care providers especially nurses to integrate Buerger Allen exercise in the care protocols of patients with DM in different health care settings.

- A comparative study should be conducted to evaluate the effectiveness of Buerger Allen Exercise with other non-pharmacological measures for improving the level of lower extremity perfusion.

- The study can be replicated by using a large sample there by findings can be generalized.

Nursing implication of the study

It had been found that Buerger Allen Exercise was valuable, easily to instruct patients with DM and improves their lower Extremities perfusion beside the medical treatment.

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