

IMPACT OF BUERGER ALLEN EXERCISE ON ANKLE BRACHIAL INDEX IN TYPE II DIABETES MELLITUS PATIENTS

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Abstract

Type II Diabetes Mellitus (T2DM) carries a high risk of long-term complications, such as blood vessel damage from the buildup of glucose in the bloodstream. The incidence of T2DM complications, such as neuropathy and Peripheral Artery Disease (PAD), is notably high. These issues are often linked to low physical activity, as indicated by abnormal Ankle Brachial Index (ABI). One physical exercise for T2DM patients that can be done actively is the Buerger Allen Exercise (BAE). This study aims to analyze the effect of BAE on ABI values in T2DM patients. The study used a pre-experimental design with post-test only control group. Sampling was conducted through total sampling, with 20 participants in the intervention group and 20 in the control group. Data were collected by measuring the ABI values of the intervention group after on session of BAE for 20 minutes, and comparing them with the control group. The data were analyzed using the Mann-Whitney U test because of the non-normal distribution. The findings revealed a significant impact of BAE on ABI values in T2DM patients (p-value 0.003 < 0.05). The average ABI value post-BAE intervention in the treatment group was 0.79 (mild obstruction), while the control group had an average of 0.69 (moderate obstruction). The BAE physical exercise improves blood flow through muscle contractions and gravity, which increases peripheral perfusion, as demonstrated by the improvement in ABI values. The findings suggest that BAE can be implemented as a routine physical activity program for people with T2DM.

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INTRODUCTION

The incidence of diabetes in 2021 showed that the number of people with diabetes was 18,325. In Selo District, 504 individuals were reported to have diabetes in 2021.¹ Type II Diabetes Mellitus (T2DM) poses a risk of complications within 5 to 10 years of the onset of the disease. Type II DM can lead to glucose accumulation in the blood, which damages blood vessels. One of the complications of T2DM is the formation of lesions in the blood vessels, which impact the peripheral nervous system, particularly Peripheral Artery Disease (PAD) (10.9%). This condition results in a limited blood supply to the extremities.²

One way to treat complications of T2DM is by increasing physical activity. A study found that 66% of

T2DM patients participated in physical activity at a moderate level.³ Regular physical activity can improve insulin response and glucose tolerance. Physical activity that affects fat metabolism, blood pressure regulation, and lipid distribution can help prevent cardiovascular disease, which is often characterized by abnormalities in the Ankle Brachial Index (ABI).⁴ Abnormalities in ABI lead to endothelial dysfunction, which impacts smooth muscle tone, blood vessels, smooth muscle cell proliferation, coagulation and fibrinolysis disorders, and persistent inflammation. These changes can manifest as Peripheral Artery Disease (PAD).⁵

The use of diabetic footwear, diabetic foot exercise, exercise that enhance foot mobility, and Buerger Allen Exercise (BAE) are some of the preventive measures that can be taken to improve peripheral circulation in the

lower extremities of diabetic patients, which can impact ABI values. Diabetic shoes have the drawback of needing to adjust to biomechanical changes and abnormalities affecting the feet, making them less efficient for independent use. Ill-fitting footwear increase the risk of diabetic foot ulcers. Diabetic foot exercise have their own limitations, such as the potential for injury if not done correctly and the risk of reduced foot sensitivity.⁶ Previous studies have found that BAE are more effective than foot exercise in improving ABI values, with the average ABI value being higher in the BAE group compared to the diabetic foot exercise group.⁷ BAE are considered a simple, low-cost physical intervention that can be performed independently to stimulate collateral circulation in the lower extremities.⁸ Changes in position and gravitational forces help empty and refill blood columns, thus improving circulation and increasing ABI values. The contraction of the gastrocnemius muscle functions as a muscle pump, pushing blood vessels and arteries to open collateral circulation pathways.⁹

One type of physical activity that can be done is the Buerger Allen Exercise (BAE). This exercise promotes better arterial and venous blood circulation by opening capillary blood vessels in the muscles. The effectiveness of the BAE has a physiological basis and has been shown to benefit patients with Type II DM, Skin Perfusion Pressure (SPP) abnormalities, Peripheral Artery Disease (PAD), neuropathy, and atherosclerosis.⁹

Previous research on physical activity in DM patients has focused on diabetic foot exercise aimed at increasing ABI values. The study discovered a significant change in ABI values before and after performing diabetic foot exercise, which are natural exercises that enhance peripheral perfusion.¹⁰ However, research on the use of active movement-based physical activity, such as the Buerger Allen Exercise, remains limited. Therefore, the researcher aims to investigate the effect of BAE for ABI values.

METHOD

This study used a pre-experimental design with a post-test only approach, including a control group. Two research groups were involved: the intervention group and the control group. The study compares these two groups, with the intervention group receiving treatment in the form of Buerger Allen Exercise once for a duration of 20 minutes, while the control group continues with routine activities. The research was conducted over a period two days, starting with collecting respondent data from health cadres, followed by visiting respondents door-to-door. On the first day, 20 respondents from the intervention group were gathered, and on the second day, 20 respondents from the control group were included. The intervention was given once, and a post-test was conducted afterward. The study was conducted in Selo Village, Boyolali Regency, in November 2023.

The research tool used was an ABI worksheet, completed by the researchers, to measure the ABI of patients. The ABI measurement was taken using a sphygmomanometer to measure systolic pressure on the right arm, left arm, right ankle, and left ankle. The ABI value was then calculated by comparing the highest systolic ankle pressure to the highest systolic arm pressure. An ABI value above 0.90 is considered normal, values ranging from 0.71 to 0.90 indicate mild obstruction, values between 0.41 and 0.70 suggest moderate obstruction, and values from 0.00 to 0.40 indicated severe obstruction. The population of this study consisted of Type II DM patients in Selo District, Boyolali Regency. A total sampling technique was used, with a total of 40 respondents—20 in the intervention group and 20 in the control group. The researchers obtained reliable data from the community health center, which showed that there are 40 patients with Type II Diabetes in Selo Village. The inclusion criteria for this study were elderly individuals with T2DM, who did not have cognitive or hearing impairments, and who did not experience mobility issues. The exclusion criteria were elderly individuals who refused to participate in the

study, patients with active foot ulcers, gangrene, or a history of amputations, uncontrolled hypertension, and obesity.

Data analysis included both univariate and bivariate analysis. Univariate analysis focused on measures of central tendency, such as the mean, median, mode, and standard deviation, to describe the ABI values for both groups. Bivariate analysis used the non-parametric Mann Whitney U test, as the data were not normally distributed based on the Shapiro-Wilk test. The normality test was performed with the Shapiro-Wilk test at a 95% confidence interval, yielding a p-value of 0.000. Since the p-value is less than 0.05, it was determined that the data do not follow a normal distribution.

RESULTS AND DISCUSSION

Univariate analysis was used to calculate the mean, median, mode, and standard deviation of the ABI values in both the control and intervention groups. After the BAE in the control group, the mean ABI value was 0.69 (SD=0.116), indicating moderate obstruction. In the intervention group, the mean ABI value after BAE was 0.79 (SD=0.086), indicating mild obstruction.

Ankle Brachial Index in Control Group

Table 1 shows the ABI value after Buerger Allen Exercise (BAE) was administered to the control group. As shown in Table 1, the mean ABI value after BAE in the control group was 0.69, indicating moderate obstruction. The results of the study involving 20 respondents in the control group, who did not undergo BAE, showed that the average ABI value was 0.69, which falls within the category of moderate obstruction. The majority of respondents did not engage in specialized activities, such as physical training, to address or prevent diabetes mellitus (DM) complications. Their activities were limited to daily routines. ABI abnormalities are commonly found in both DM and non-DM patients with low levels of physical activity.⁴

Table 1. Ankle Brachial Index Following Buerger Allen Exercise in Control Group (n=20)

Variable	N	Mean	Median	Modus	SD
ABI after being BAE in control group	20	0.69	0.71	0.71	0.116

Patients with Type II DM often experience changes in blood vessel capillary elasticity, thickening of the blood vessel walls, and the formation of plaques or thrombi due to hyperglycemia. These changes impede peripheral vascularization, leading to lower ABI values than the normal range (0.91-1.31). Many patients with peripheral artery disease (PAD) are asymptomatic, making the ABI test crucial for diagnosing PAD.¹¹

Patients with T2DM are at a higher risk for PAD, which is characterized by a decrease in ABI values. Tingling, particularly in the feet, is a common symptom of poor circulation in these patients. Individuals with Type II DM who have low ABI values are often unaware of the blockages in their leg blood vessels because PAD is sometimes asymptomatic. Therefore, it is essential to perform an ABI test to assess blood circulation in the legs.^{12,13}

Other research also highlights factors affecting ABI in both DM and non DM groups, including age, physical activity, and smoking habits. Regular physical activity benefits fat metabolism, blood pressure regulation, and lipid distribution, which can help prevent cardiovascular diseases characterized by ABI abnormalities.¹⁴

The results of this study are inconsistent with previous studies, which showed an ABI value of 0.90, categorized as mild obstruction.¹⁵ Several factors can influence ABI values. Prior studies have identified factors such as age, duration of diabetes, hypertension history, increased HbA1c levels, serum creatinine, and history of retinopathy as contributors to ABI values.¹⁶ Therefore, the differences in ABI values between this study and previous research may be due to variations in

the characteristics of the respondents, such as age, duration of diabetes, and medical history.

Ankle Brachial Index in Intervention Group

Table 2 shows the ABI value after Buerger Allen Exercise (BAE) was administered to the intervention group. As shown in Table 2, the mean ABI value after BAE in the intervention group was 0.79, indicating mild obstruction.

Table 2. Ankle Brachial Index Following Buerger Allen Exercise in Intervention Group (n=20)

Variable	N	Mean	Median	Modus	SD
ABI after being in intervention group	20	0.79	0.74	0.71	0.086

The ABI value in the 20 respondents in the intervention group was 0.79, which falls within the mild obstruction category. This non-invasive test is used to screen patients for arterial insufficiency, assess lower extremity circulation, identify the risk of vascular damage, and determine the appropriate next steps. The prevalence of low or abnormal ABI is higher in people with diabetes and is linked to factors like age, the duration of diabetes, and gender.

Buerger Allen Exercise (BAE) effectively increase ABI values. The variations in movement that stimulate muscle pumps and utilize gravity in the legs can enhance perfusion in the feet. Dorsiflexion and plantar flexion movements performed according to established protocols can alleviate blood flow restrictions caused by atherosclerotic obstructions. BAE helps relax leg muscles, while also causing muscle contractions that stimulate the release of Nitric Oxide (NO) in blood vessels, improving vessel flexibility and promoting optimal circulation. Improved vascularization from BAE increases blood flow pressure in the legs (doraslis pedis), which in turn raises the ratio when compared to brachial pressure. An increase in this blood pressure ratio signifies improved circulation and a reduced risk of neuropathy and ulcers in individuals with diabetes.⁹

Research by Lamkang shows that BAE effectively improves peripheral circulation. Diabetic patients who perform BAE experience increased walking ability, reduced pain (intermittent claudication), decreased tingling, and reduced leg edema. These improvements are reflected in enhanced peripheral circulation, as evidenced by changes in ABI values. The enhanced circulation from BAE results from specific exercise methods and variations that optimize lower leg movements, stimulating muscle pump actions and utilizing gravity to improve blood flow toward the heart and throughout the body.

BAE combines muscle pump techniques with gravity-assisted movements. These leg movements aid venous return by helping blood vessels alternate between emptying and filling, ensuring smooth blood transportation in the lower legs toward the heart.¹⁷ Standing postures, facilitated by gravity, improve blood flow in the splanchnic, pelvis, and leg vessels. This postural movement promotes blood circulation, which aligns with previous research.¹⁸ noted that BAE plays a crucial role in the healing process of diabetic foot wounds. By improving peripheral circulation through gravity-changing techniques and muscle contractions from dorsiflexion and plantar flexion movements, BAE promotes better blood flow in the lower extremities.

BAE is an effective exercise modality for individuals with peripheral tissue perfusion disorders, particularly diabetics. The simplicity, affordability, and efficiency of BAE make it an accessible treatment. The independence (self-care) of diabetics in managing and preventing macrovascular complications is critical. Nurses must recognize that diabetic patients with peripheral perfusion disorders have the potential to care for themselves in meeting their daily needs, maintaining health, and achieving well-being. Optimal health can be achieved when individuals are empowered to independently manage their care.¹¹

BAE is an alternative activity that can reduce diabetes complications, especially ABI abnormalities. Its ease of use, speed, and versatility make it a valuable

complement to other activities. Regular engagement in BAE can improve peripheral circulation and help prevent diabetes-related complications.

Effect of Buerger Allen Exercise on Ankle Brachial Index in T2DM

Table 3 presents the analysis of the impact of ABE on the ABI in patients with T2DM. From Table 3, it can be concluded that the study findings revealed a significant difference in how BAE affected the ABI value in these patients.

Table 3. Effect of Buerger Allen Exercise on Ankle Brachial Index in Type II DM

Variable	N	Mean	Z	Asymp.Sig. (2-tailed)
Intervention group	20	25.90	-2.947	0.003
Control group	20	15.10		

A study on patients with T2DM investigating the impact of BAE on the ABI found a significant difference. The Mann-Whitney U test produced a significance value of 0.003, which indicates that the asymptotic significance (2-tailed) of $0.003 < 0.05$ shows a difference in ABI values between the control and intervention groups. This significant difference suggests that BAE affects the ABI value. The factors that affect ABI are related to the increased perfusion of the lower extremities after performing the Buerger Allen Exercise. The leg elevation phase, lasting one to two minutes in a supine position, helps improve blood flow to the heart, expand the heart chamber walls, and promote further muscle contraction. The lowering phase, lasting two to five minutes in a seated position with the legs hanging, helps alter gravity, increasing blood flow from the heart to the upper or lower extremities. The final phase, the horizontal or resting phase, lasts about five minutes in a supine position and is beneficial for enhancing blood flow or reperfusion to the legs as the effects of gravity subside.⁷

This finding aligns with the research by Aruna and Thenmozi, which showed an increase in nitric oxide

levels that are essential for improving peripheral blood flow in the legs after 3 months of BAE. Other studies also support this, concluding that BAE can help improve blood flow obstruction in diabetic feet caused by the diabetes disease process.¹⁹

Several studies that have used BAE as an exercise for DM patients show an increase in blood flow through movements that utilize muscle contractions and gravity. Lower leg movements can enhance peripheral blood vessel circulation. A muscle pump is produced by leg movements that cause muscle contractions, there by activating a blood vessel with leg muscle movements against blood flow pressure, allowing blood to flow more smoothly to the heart and throughout the body.²⁰

When performed consistently, BAE can relieve and improve peripheral perfusion disorders in DM patients' feet. BAE helps repair blood vessel walls (endothelium) by increasing Nitric Oxide (NO), ultimately aiding in the repair of atherosclerosis.¹⁸

Earlier studies have shown that the BAE method is effective in improving blood flow to diabetic feet and can be a simple and cost-effective way to treat circulation problems. In this study, BAE was carried out over 6 sessions, with 6 days of exercise, and each session lasted 15 minutes.⁹

A study looked into how BAE affects circulation in the lower limbs. The findings revealed that BAE is effective in improving blood flow in cases of diabetic foot ulcers (DFU), as changes in position and gravity help the blood flow. Moreover, the contraction of the gastrocnemius muscle, acting as a muscle pump, helps open veins and arteries to create alternative circulation pathways.⁹ In this study, BAE was performed twice daily for 17-20 minutes over the course of 3 weeks. The study found a significant effect, where the ABI was lower in the control group compared to the intervention group. BAE can be performed daily to prevent or reduce other diabetes related complications. The clinical implication of an increased ABI due to the Buerger Allen Exercise is that it will impact circulation values and, in the long term, reduce the occurrence of PAD.

CONCLUSION

Based on the results of the study, the ABI value in the control group was categorized as moderate obstruction, while the ABI value in the intervention group was categorized as mild obstruction. A significant effect was observed from the administration of BAE as physical training on ABI values in patients with T2DM. These findings can serve as a reference for developing a routine, ongoing physical exercise program involving the community and health cadres. Future research could focus on exploring interventions related to the pillars of diabetes mellitus management.

The limitation of this study is that the intervention was performed only once, so the results may not be optimal. Therefore, the researchers recommend that it be continued regularly by health cadres as part of the four-pillar diabetes management program, especially for physical activity.

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