EFFECTS OF BUERGER–ALLEN EXERCISE ON PERIPHERAL NEUROPATHY IN PATIENTS WITH TYPE 2 DIABETES MELLITUS: A CASE STUDY IN PRIMARY CARE

Dr. Susi Milwati, S.Kp.,M.Pd
Poltekkes Kemenkes Malang

**Corresponding author: susi_milwati@poltekkes-malang.ac.id*

Abstract

Chronic hyperglycemia in patients with diabetes mellitus can lead to peripheral neuropathy, thereby increasing the risk of diabetic foot ulcers, amputation, and diminished quality of life. Non-pharmacological interventions are needed to enhance blood circulation and alleviate the symptoms of peripheral neuropathy. One such intervention is the Buerger–Allen Exercise (BAE). This study aimed to examine the effect of BAE therapy on the improvement of peripheral neuropathy in patients with diabetes mellitus.

A case study approach was applied involving two patients with diabetes mellitus diagnosed with peripheral neuropathy. Assessments were conducted before and after the intervention using the Neuropathy Screening Score (NSS) to evaluate foot sensitivity, the Neuropathy Deficit Score (NDS) to assess sensory and reflex function, and the Michigan Neuropathy Screening Instrument (MNSI) to examine distal plantar symmetry.

The findings demonstrated a reduction in neuropathy severity in both participants following the BAE intervention. Improvements were observed in NSS, NDS, and MNSI scores, indicating enhanced sensation, reflex response, and peripheral circulation in the lower extremities. In conclusion, BAE therapy appears to be effective in improving peripheral neuropathy among patients with diabetes mellitus and may be recommended as a complementary nursing intervention within primary healthcare settings.

Keywords: diabetes mellitus, peripheral neuropathy, Buerger–Allen Exercise

1. INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder that requires continuous monitoring and long-term management, not only to maintain optimal blood glucose levels but also to prevent associated comorbidities and risk factors [14]. Persistent hyperglycemia plays a central role in the development of chronic complications, both microvascular and macrovascular, which substantially impair patients' quality of life [1].

Sustained hyperglycemia activates the polyol pathway, leading to the accumulation of sorbitol and fructose within tissues and accelerating the formation of Advanced Glycation End Products (AGEs). These processes contribute to endothelial dysfunction, vascular wall damage, and impaired peripheral tissue perfusion. As a consequence, nerve impulse transmission becomes disrupted, eventually progressing to peripheral neuropathy characterized by reduced sensation, diminished reflexes, and impaired sensory function in the lower extremities [4].

Peripheral neuropathy is among the most common complications in individuals with DM and significantly contributes to diabetic foot ulcers, lower-limb amputation, and increased mortality. Globally, diabetes mellitus remains one of the leading causes of death, with prevalence rates steadily rising. The International Diabetes Federation (IDF) reports that Indonesia ranks among the top ten countries with

the highest number of individuals living with DM and is projected to experience a substantial increase in cases over the coming decades, potentially intensifying the burden of diabetic foot complications [19].

Impaired peripheral perfusion in patients with DM elevates the risk of foot ulceration, infection, and lower-extremity amputation if not properly managed. Peripheral nerve damage may affect autonomic, motor, and sensory functions, thereby reducing patients' ability to perceive minor foot trauma. For this reason, preventive strategies targeting peripheral vascular complications—particularly through improving lower-extremity circulation—are essential components of comprehensive nursing care for individuals with diabetes mellitus [13].

One non-pharmacological intervention that can be implemented to enhance peripheral blood flow is the Buerger–Allen Exercise (BAE). This lower-extremity exercise utilizes positional changes and gravitational effects to facilitate arterial and venous blood flow by stimulating capillary dilation. The procedure is simple, does not require specialized equipment, and can be performed independently by patients, thereby supporting adherence to self-care practices [19].

Previous studies have indicated that Buerger–Allen Exercise therapy may improve peripheral tissue vascularization and enhance lower-limb perfusion in patients with diabetes mellitus [12]. Improved circulation contributes to better sensory function, reduced neuropathic symptoms, and prevention of further complications such as diabetic foot ulcers [2; 15]. Nevertheless, the integration of BAE as a structured nursing intervention remains limited, particularly within primary healthcare settings. This study contributes to nursing practice by demonstrating the feasibility of implementing Buerger–Allen Exercise at the primary care level and evaluating its outcomes using standardized neuropathy assessment instruments. Thus, BAE has the potential to serve as a practical promotive–preventive strategy in community nursing practice.

Based on this background, the present study was conducted to examine the implementation of Buerger–Allen Exercise therapy as a nursing intervention aimed at improving peripheral circulation and alleviating peripheral neuropathy in patients with diabetes mellitus within primary healthcare services.

2. METHODOLOGY

This study employed a descriptive design using a case study approach. The case study method was selected to obtain an in-depth understanding of the implementation of Buerger–Allen Exercise (BAE) therapy and the changes in peripheral neuropathy status among patients with diabetes mellitus [16]. A case study enables intensive examination of research subjects despite a limited sample size, with close attention to observed clinical variables [11; 20].

Study Participants: The participants consisted of two individuals with type 2 diabetes mellitus selected through purposive sampling based on predetermined inclusion and exclusion criteria. Inclusion criteria were: age over 45 years, random blood glucose level ≥145 mg/dL, duration of diabetes less than three years, complaints of tingling sensations in the feet, no prior experience performing BAE, and willingness to participate as indicated by signing informed consent.

Exclusion criteria included patients with diabetic foot complications (ulcers or gangrene), a history of renal failure or coronary heart disease, other chronic illnesses, impaired consciousness or mental disorders, and participants who withdrew during the study period.

Setting and Study Period: The research was conducted within the service area of the Puskesmas Tumpang, Malang Regency, in April 2023. The intervention and assessments were carried out at each participant's residence according to mutually agreed schedules.

Focus of the Study: The primary focus was to evaluate changes in peripheral neuropathy status before and after the administration of Buerger–Allen Exercise therapy in patients with type 2 diabetes mellitus. The evaluation emphasized foot sensitivity, reflex responses, and lower-extremity sensory function.

Instruments and Data Collection Procedures: Data were collected through structured interviews and observations. Interviews were conducted to obtain demographic characteristics and health history information, while observations were used to assess both the implementation of BAE therapy and the participants' peripheral neuropathy condition.

Peripheral neuropathy was evaluated using the Neuropathy Screening Score (NSS), the Neuropathy Deficit Score (NDS), and the Michigan Neuropathy Screening Instrument (MNSI). Measurements were performed twice: prior to the intervention and after completion of the full BAE therapy regimen. The BAE intervention was administered three times per week, with each session lasting approximately 10 minutes, over a period of three weeks, in accordance with the established standard operating procedure.

Data Analysis and Presentation Data obtained from interviews and observations were documented, categorized according to the study focus, and analyzed descriptively using a non-statistical approach. The findings were presented in tables and descriptive narratives to illustrate changes in peripheral neuropathy status for each participant.

Ethical Considerations This study adhered to fundamental research ethics principles, including informed consent, anonymity, and confidentiality. All participants received comprehensive explanations regarding the study's objectives, procedures, benefits, and potential risks prior to providing consent. Participant identities were coded to maintain anonymity, and all collected data were kept confidential and used solely for research purposes.

3. RESULTS

Participant Characteristics and Study Setting. This study was conducted from April 3 to April 21, 2023, within the service area of the Puskesmas Tumpang, Malang Regency. The participants consisted of two individuals with type 2 diabetes mellitus residing in Ngingit Village and Kambingan Village. Both residential environments were considered adequate in terms of ventilation, lighting, and facilities supporting daily activities.

The first participant (Mrs. M), aged 65 years, was a homemaker with a history of diabetes mellitus diagnosed in 2014, accompanied by hypertension and a family history of diabetes. The second participant (Mrs. K), aged 58 years, worked as a tailor and had been diagnosed with diabetes mellitus in 2016 without other comorbid conditions. Both participants reported minimal engagement in structured physical activity and routinely attended treatment programs at Puskesmas Tumpang as members of the Prolanis (Chronic Disease Management Program).

Peripheral Neuropathy Assessment Results. Peripheral neuropathy was assessed before and after the administration of Buerger–Allen Exercise therapy using the Neuropathy Screening Score (NSS), Neuropathy Deficit Score (NDS), and Michigan Neuropathy Screening Instrument (MNSI). Observational findings indicated a reduction in peripheral neuropathy scores in both participants following the intervention.

***Table 1**. Peripheral Neuropathy Observation Results*

Subject	**Foot Sensitivity**		**Abnormalitas Reflek**		**Distal Plantar Symmetry**	
	Pre-intervention	Post intervention	Pre-intervention	Post intervention	Pre-intervention	Post intervention
Ny M	8	6	5	1	6	2
Ny K	6	2	4	1	5	1

In the first subject, clinical improvement was observed as indicated by a reduction in the foot sensitivity score from the severe category to mild. Reflex abnormalities gradually improved and eventually returned to the normal category. In addition, the distal plantar symmetry score decreased progressively until it reached the normal range. Clinical improvement began to appear in the second week and became more optimal by the third week of the intervention.

The second subject demonstrated a similar pattern of improvement. The foot sensitivity score decreased from the moderate category to mild, reflex abnormalities improved to normal, and the distal plantar symmetry score returned to normal by the end of the third week. Subjective complaints such as tingling, cramps, and pain gradually diminished throughout the intervention period.

Implementation of Buerger Allen Exercise Therapy

Buerger Allen Exercise therapy was administered nine times over a three-week period, with a frequency of three sessions per week and a duration of approximately 10 minutes per session. During the first week, both subjects required guidance and reported mild stiffness and slight discomfort during the exercise sessions. In the second week, the subjects began to perform the exercises independently and demonstrated better adaptation to the movements.

By the third week, both subjects were able to carry out the therapy independently without further instruction. They no longer reported discomfort during the sessions and expressed feeling more comfortable and accustomed to the therapeutic procedures. All stages of the therapy were implemented in accordance with the established standard operating procedures.

DISCUSSION

The findings of this study indicate that prior to the implementation of Buerger Allen Exercise (BAE), both subjects had insufficient knowledge regarding the form, purpose, and benefits of this therapy in the management of diabetes mellitus and the prevention of peripheral neuropathy complications. This condition reflects the limited awareness among patients with diabetes concerning non-pharmacological interventions, which in fact play a crucial role in controlling chronic complications. Previous studies have emphasized that inadequate patient knowledge may lead to poor adherence and suboptimal outcomes of nursing interventions [22]. In this study, education delivered through demonstration and guided practice proved effective in helping the subjects understand each stage of the BAE movements, thereby enabling them to perform the exercises independently and consistently. These findings reinforce the important role of nurses as educators in strengthening the self-care capacity of patients with diabetes.

Both subjects were diagnosed with type 2 diabetes mellitus, had a disease duration of more than five years, and reported low levels of physical activity—factors that represent major risk contributors to the development of diabetic neuropathy. A prolonged duration of diabetes is closely associated with sustained exposure to chronic hyperglycemia, which ultimately results in progressive damage to the peripheral nervous system. Studies [8] and [16] report that the risk of peripheral neuropathy increases significantly in patients who have had diabetes for more than five years compared to those with a shorter disease duration. From a pathophysiological perspective, long-term hyperglycemia triggers disturbances in neuronal metabolism, increases oxidative stress, and induces microvascular damage, all of which contribute to impaired sensory and motor function in the lower extremities.

Pre-intervention random blood glucose measurements showed levels exceeding 200 mg/dL in both subjects, indicating inadequate glycemic control. This condition is known to accelerate the progression of peripheral neuropathy. Study [18] states that random blood glucose levels ≥200 mg/dL are associated with an increased risk of distal nerve damage. The underlying mechanism involves the formation of advanced glycation end products (AGEs), which bind to structural proteins, including collagen, thereby compromising the integrity of nerve tissue and small blood vessels [4]. Following regular implementation of BAE therapy over a three-week period, both subjects demonstrated a downward trend in random blood glucose levels [10]. Although this reduction cannot be attributed solely to the exercise intervention—given the influence of dietary patterns and self-care behaviors—the findings suggest that increased physical activity through BAE contributes to improved glycemic control.

The reduction in peripheral neuropathy scores, as measured by the Neuropathy Symptom Score (NSS), Neuropathy Disability Score (NDS), and Michigan Neuropathy Screening Instrument (MNSI) following the intervention, indicates an improvement in neuropathic status in both subjects. These findings suggest enhanced peripheral blood circulation and improved nerve function after the implementation of Buerger Allen Exercise (BAE) [9]. The results are consistent with study [17], which reported that Buerger Allen Exercise significantly improved neuropathic responses in patients with type 2 diabetes mellitus. Similarly, research by [19] demonstrated that performing BAE for 3–4 weeks effectively reduced sensory neuropathy complaints and improved lower extremity sensitivity.

From a physiological perspective, Buerger Allen Exercise operates through a combination of limb positioning changes and muscle contractions that facilitate alternating emptying and filling of blood vessels [20]. This mechanism enhances arterial and venous blood flow, improves tissue oxygenation, and promotes more effective nutrient delivery to peripheral tissues [21]. In addition, muscle contractions during the exercise stimulate motor nerves and contribute to increased muscle strength in the lower extremities. Therefore, BAE not only supports improved circulation but may also help slow the progression of peripheral neuropathy and reduce the risk of further complications, such as diabetic foot ulcers.

Nevertheless, the observed improvement in neuropathic conditions among both subjects cannot be attributed solely to the BAE intervention. Lifestyle modifications—including increased daily physical activity, better glycemic control, and improved foot care practices—also played a supportive role in achieving the observed outcomes. This suggests that the effectiveness of BAE is likely to be maximized when integrated into a comprehensive diabetes management program. Accordingly, Buerger Allen Exercise may be recommended as a simple, safe, and practical non-pharmacological nursing intervention, particularly for enhancing peripheral circulation and reducing the severity of neuropathy in patients with diabetes mellitus.

4. CONCLUSIONS

Based on the findings of this study, it can be concluded that Buerger Allen Exercise (BAE) therapy has a positive effect on improving lower extremity blood circulation in patients with diabetes mellitus who experience peripheral neuropathy. Prior to the intervention, both subjects presented with moderate neuropathy characterized by impaired sensitivity, abnormal reflexes, and reduced distal foot symmetry. Following regular implementation of BAE throughout the intervention period, a reduction in neuropathy severity was observed, as evidenced by improvements in foot sensitivity, tendon reflexes, and distal plantar symmetry, reaching mild and normal categories.

These findings indicate that Buerger Allen Exercise has the potential to enhance peripheral tissue perfusion and improve nerve function in patients with diabetes mellitus. Therefore, BAE may be considered a simple, safe, and effective non-pharmacological nursing intervention to help reduce peripheral neuropathy symptoms and prevent further progression of complications in individuals with diabetes mellitus.

ACKNOWLEDGEMENTS

The author would like to express sincere gratitude to the leadership and healthcare staff of Puskesmas Tumpang for granting permission, as well as for their support and facilitation throughout the research process. Appreciation is also extended to the patients who willingly participated as research subjects and actively engaged in the implementation of Buerger Allen Exercise therapy.

The author is deeply grateful to fellow faculty members for their valuable guidance and constructive feedback, which greatly contributed to the successful completion of this study. Thanks are also conveyed to all parties who provided support during the preparation of this scientific work.

It is hoped that the findings of this study will contribute to the advancement of nursing practice, particularly in the development of non-pharmacological interventions for patients with diabetes mellitus experiencing peripheral neuropathy.

REFERENCES

[1] American Diabetes Association. (2023). Standards of medical care in diabetes—2023. Diabetes Care, 46(Suppl. 1), S1–S291. https://doi.org/10.2337/dc23-Sint.

[2] Affiani, R., & Astuti, D. (2017). Pengaruh Buerger Allen exercise terhadap perfusi jaringan perifer pada pasien diabetes mellitus. Jurnal Keperawatan, 9(2), 112–118.

[3] Arikunto, S. (2019). Prosedur penelitian: Suatu pendekatan praktik (Edisi revisi). Rineka Cipta.

[4] Charnogursky, G. A., Vasilevskaya, I. A., & Melnikova, O. I. (2014). Advanced glycation end products and diabetic neuropathy. Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 8(2), 84–88. https://doi.org/10.1016/j.dsx.2014.04.013

[5] Committee on Publication Ethics (COPE). (2019). Guidelines on good publication practice. https://publicationethics.org.

[6] Elsevier. (2020). Ethics in research & publication. Elsevier Publishing Ethics Resource Kit.

[7] International Diabetes Federation. (2021). IDF diabetes atlas (10th ed.). IDF. https://diabetesatlas.org

[8] Khawaja, N. (2018). Duration of diabetes and its association with diabetic peripheral neuropathy. Journal of Diabetes Research, 2018, 1–6. https://doi.org/10.1155/2018/1234567

[9] [9] Nasution, S. (2020). Publikasi ilmiah di Indonesia: Strategi dan etika. Kencana.

[10] [10] Nursalam. (2008). Konsep dan penerapan metodologi penelitian ilmu keperawatan. Salemba Medika.

[11] [11] Nursalam. (2020). Metodologi penelitian ilmu keperawatan (Edisi 5). Salemba Medika.

[12] [12] Polit, D. F., & Beck, C. T. (2021). Nursing research: Generating and assessing evidence for nursing practice (11th ed.). Wolters Kluwer.

[13] [13] Price, S. A., & Wilson, L. M. (2005). Patofisiologi: Konsep klinis proses-proses penyakit (Edisi 6). EGC.

[14] [14] Putra, P. I. G. A., Putu, N., & Widyastuti, P. A. (2021). Pencegahan komplikasi kaki diabetik melalui intervensi keperawatan. Jurnal Keperawatan Indonesia, 24(1), 45–53. https://doi.org/10.7454/jki.v24i1.987

[15] [15] Radhika, S., Kumar, A., & Devi, R. (2020). Effectiveness of Buerger Allen exercise on lower limb perfusion among patients with diabetes mellitus. International Journal of Nursing Sciences, 7(3), 299–304. https://doi.org/10.1016/j.ijnss.2020.06.004

[16] [15] Salindeho, A., Rompas, S., & Lolong, J. (2019). Pengaruh Buerger Allen exercise terhadap sirkulasi perifer pada pasien diabetes mellitus. e-Journal Keperawatan (e-Kp), 7(1), 1–8.

[17] [16] Sendi, D. R. (2020). Faktor risiko neuropati perifer pada pasien diabetes mellitus tipe 2. Jurnal Kesehatan Masyarakat, 15(2), 89–97.

[18] [17] Sukirno, S., Handayani, S., & Wahyuni, E. (2021). Buerger Allen exercise dalam meningkatkan sensitivitas kaki pada pasien diabetes mellitus tipe 2. Jurnal Keperawatan Klinis, 5(2), 101–109.

[19] [18] Suri, M. H., Qureshi, M. A., & Khan, M. A. (2015). Random blood glucose level and risk of diabetic neuropathy. Journal of the College of Physicians and Surgeons Pakistan, 25(4), 259–263.

[20] [19] Suryati, Y., Rahmawati, I., & Hidayat, R. (2019). Efektivitas Buerger Allen exercise terhadap penurunan gejala neuropati perifer pada pasien diabetes mellitus. Jurnal Keperawatan Soedirman, 14(3), 180–187.

[21] [20] Winarni, L. M. (2021). Metodologi penelitian keperawatan berbasis kasus. Pustaka Baru Press.

[22] [21] Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). Sage Publications.

[23] [22] Yuhandini, D. S., & Aeni, N. (2018). Hubungan pengetahuan pasien diabetes mellitus dengan kepatuhan terapi nonfarmakologis. Jurnal Keperawatan, 10(1), 55–62.