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The Combination of Insulin Therapy and Diabetic Foot Exercises in Reducing Blood Glucose Levels and Improving Peripheral Perfusion in a Patient with Type 2 Diabetes Mellitus: A Case Report

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Abstract: Type 2 diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia due to insulin resistance and impaired insulin secretion. Poor glycemic control may increase the risk of peripheral vascular disorders, neuropathy, diabetic foot ulcers, and lower-extremity complications. In addition to insulin therapy, diabetic foot exercises may support glucose utilization, improve peripheral circulation, and enhance lower-limb perfusion. This study used a case report design with a nursing care process approach involving a 62-year-old female patient diagnosed with type 2 diabetes mellitus. The intervention consisted of prescribed insulin therapy and diabetic foot exercises performed once daily for seven consecutive days. Random blood glucose levels and Ankle Brachial Index values were measured before and after the intervention to evaluate changes in glycemic control and peripheral perfusion. The findings showed a gradual reduction in random blood glucose levels from 226 mg/dL on the first day to 169 mg/dL on the seventh day. The Ankle Brachial Index also increased from 0.77 to 0.87, indicating improved peripheral perfusion. These changes suggest that combining insulin therapy with diabetic foot exercises may support glucose metabolism and enhance blood flow in the lower extremities. The combination of insulin therapy and diabetic foot exercises may be considered a complementary nursing intervention to improve glycemic control and peripheral perfusion in patients with type 2 diabetes mellitus.
Keywords: Type 2 diabetes mellitus; Blood glucose; insulin; Peripheral perfusion; Diabetic foot exercises

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder characterized by an increase in blood glucose levels, commonly referred to as hyperglycemia, which occurs due to insulin dysfunction (Hernando-Garijo et al., 2024). Diabetes mellitus is also considered a hereditary disease, as parents may pass genetic susceptibility to their children (Abbas et al., 2023).

The International Diabetes Federation (IDF) reported that approximately 589 million adults worldwide are currently living with diabetes, equivalent to 11.1% of the global adult population, or 1 in 9 adults. This number is projected to increase to 853 million by 2050, with the majority of cases occurring in low- and middle-income countries (IDF, 2025). In Indonesia, the prevalence of diabetes also remains high. The 2023 Indonesian Health Survey reported that 11.7% of the population aged ≥15 years had diabetes mellitus, increasing from 10.9% in 2018. This increasing prevalence places Indonesia fifth in Southeast Asia and indicates that diabetes is a significant public health problem at both global and national levels (IDF, 2025).

Diabetes is generally classified into two main types. Type 1 diabetes mellitus usually occurs in children and adolescents due to autoimmune destruction of pancreatic beta cells, requiring patients to use insulin throughout their lives. In contrast, type 2 diabetes mellitus is more common in adults and is characterized by insulin resistance and a gradual decline in insulin production. Risk factors include obesity, family history, and an inactive lifestyle (WHO, 2019). Type 2 diabetes mellitus is strongly associated with low physical activity, diets high in sugar and fat, and excess body weight (Balqis et al., 2025). Common symptoms include increased urination, excessive thirst, increased appetite, discomfort or itching of the skin, and wounds that are difficult to heal (PERKENI, 2021). If not managed properly, diabetes can lead to serious complications, such as nerve damage, stroke, kidney failure, and amputation (WHO, 2020).

Several factors contribute to the development of diabetes mellitus, including age, sex, and physical activity or exercise. Increasing age may lead to a decline in organ function, which affects insulin production and causes glucose intolerance. Meanwhile, women may have a higher risk of developing diabetes mellitus because menopause is associated with reduced insulin sensitivity (Ferreira et al., 2024). In addition, lack of physical activity or exercise may contribute to the occurrence of diabetes mellitus. Physical inactivity can increase the percentage of body fat, particularly intra-abdominal fat, which may lead to insulin resistance and subsequently result in diabetes mellitus (Vrátná et al., 2022).

Diabetic neuropathy is one of the most common complications among patients with diabetes mellitus. This condition is characterized by impaired peripheral nerve function due to long-term hyperglycemia, which may manifest as reduced sensation, tingling, numbness, pain, and weakness in the feet (Zhu et al., 2024). Diabetic neuropathy occurs as a complication caused by high blood glucose levels. Persistent hyperglycemia, accompanied by impaired carbohydrate, lipid, and protein metabolism due to insulin dysfunction, contributes to the development of diabetes mellitus and its complications (Ardiani et al., 2021). Therefore, blood glucose control is needed through a combination of pharmacological and non-pharmacological therapies. Pharmacological therapy includes insulin administration in patients with type 2 diabetes mellitus who are unable to achieve optimal glycemic control through oral hypoglycemic agents. Insulin helps reduce blood glucose levels by increasing glucose uptake into body cells (PERKENI, 2021).

However, insulin use alone is often not sufficiently effective if it is not accompanied by healthy lifestyle changes and regular physical activity. Physical activity can increase insulin sensitivity, improve glucose metabolism, and help enhance peripheral blood circulation, making it important in the management of diabetes mellitus. One non-pharmacological therapy that is easy for patients with type 2 diabetes mellitus to perform is diabetic foot exercise. Diabetic foot exercise is a lower-extremity movement exercise aimed at increasing blood flow, strengthening foot muscles, maintaining joint flexibility, and preventing complications such as peripheral neuropathy and diabetic foot ulcers (Gholami et al., 2024). Diabetic foot exercise is a basic exercise that combines stretching, muscle strengthening, and joint movements of the feet and ankles. This activity is beneficial for maintaining foot health and helping regulate blood glucose levels. It is recommended that this exercise be performed regularly 3 to 4 times per week, for 15 to 30 minutes per session (Balqis et al., 2025). Diabetic foot exercise can improve blood circulation, strengthen small muscles, and prevent foot deformities. This is in line with the study by Monteiro et al. (2020), which found that diabetic foot exercise had an effect on differences in blood glucose levels before and after the intervention, with a p-value of <0.005.

Based on the aforementioned problems, diabetic foot exercise as a non-pharmacological therapy has the potential to reduce blood glucose levels. Therefore, the researchers intended to conduct a more in-depth study on the combination of pharmacological and non-pharmacological therapies, namely insulin therapy and diabetic foot exercise, in reducing blood glucose levels in patients with type 2 diabetes mellitus.

RESEARCHMETHOD

This case report employed a descriptive design based on the nursing process because the subject was a single patient who was examined in depth, with nursing care presented in detail from assessment to evaluation. The main focus was to describe the clinical problems experienced by the patient and the nursing interventions provided systematically through the stages of assessment, nursing diagnosis, planning, implementation, and evaluation. The subject of this case report was Mrs. A, a 62-year-old woman whose highest level of education was senior high school. She worked as a housewife, was widowed, was Muslim, and lived in Bunutwetan Village, Pakis, Malang, Indonesia. The patient was diagnosed with type 2 diabetes mellitus.

The patient was selected purposively based on predetermined inclusion criteria, namely being diagnosed with type 2 diabetes mellitus, having no history of other disease complications that could interfere with the implementation of the intervention, having intact lower extremities without wounds, ulcers, or deformities, and being cooperative and willing to participate in the entire intervention process by providing written informed consent. This condition emphasized the importance of independent nursing interventions that could be performed by the patient at home after receiving adequate education. The patient had a supportive home environment, which enabled the implementation of diabetic foot exercises every day according to the research protocol. Ethical principles were applied by obtaining written informed consent before the intervention was conducted. The patient's identity was kept confidential by using initials in the documentation. All procedures were carried out according to clinical standards and were non-invasive. The patient was given a complete explanation regarding the objectives, procedures, benefits, and minimal risks of the intervention.

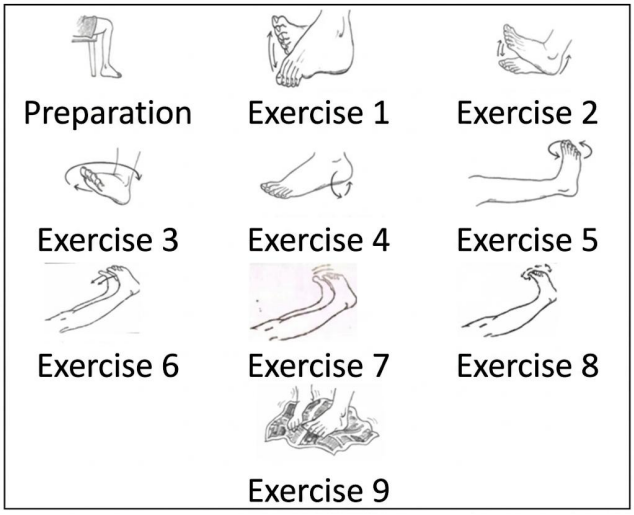
A comprehensive assessment was conducted on the first day, including anamnesis consisting of disease history, chief complaints, and current medication. The physical examination included vital signs, peripheral pulse palpation, capillary refill time, extremity temperature, skin color and integrity, and ankle range of motion. Blood glucose levels were measured using a glucometer. The Ankle Brachial Index (ABI) was measured by assessing systolic blood pressure in the dorsalis pedis or posterior tibial artery of the foot and comparing it with systolic blood pressure in the brachial artery of the arm.

The initial assessment showed that the patient frequently complained of tingling in both feet, especially at night, and reported decreased sensation in the feet, which made her often unaware of minor wounds. The physical examination showed blood pressure of 118/88 mmHg, pulse rate of 88 beats per minute, respiratory rate of 20 breaths per minute, and body temperature of 36.5°C. The dorsalis pedis artery pulse was weak bilaterally, with capillary refill time in both feet of more than three seconds. The feet felt colder than other parts of the body. Sensory testing using a 10-gram Semmes-Weinstein monofilament showed decreased sensation at several points on the bilateral plantar pedis. The ankle range of motion was limited, with mild pain during dorsiflexion and plantar flexion. The Ankle Brachial Index (ABI) value was 0.77, indicating moderate peripheral arterial disease, with a random blood glucose level of 226 mg/dL. At the initial assessment, the patient was receiving Apidra insulin 6 units before meals and Lantus insulin 8 units before bedtime.

On the first meeting, assessment and informed consent were conducted. The intervention began with education about diabetes mellitus and foot care for patients with diabetes during the second meeting, followed by random blood glucose measurement using a glucometer as the pre-test. Insulin was then administered before meals, after which the patient ate and rested briefly. This was followed by demonstration and role play related to diabetic foot exercises. The diabetic foot exercise intervention was carried out for seven consecutive days. The combined intervention was provided daily for seven consecutive days at the patient's home according to the following sequence.

Diabetic Foot Exercises

Diabetic foot exercises are a series of physical exercises involving various foot movements based on continuous, rhythmic, progressive, and endurance principles. The exercises were performed once daily in the morning for 15–20 minutes per session. This method was selected because diabetic foot exercises have been shown to improve peripheral blood circulation in patients with diabetes mellitus. Before performing the exercises, the patient sat upright on a chair with both feet placed on the floor. The movements included the following:



Gambar 1. Gerakan Senam Kaki Diabetes

1. Exercise 1 was performed in 10 repetitions by moving the toes of both feet into a claw-like position and then straightening them again.
2. Exercise 2 was performed in 10 repetitions by lifting the toes while keeping the heels on the floor, lowering the toes, then lifting and lowering the heels.
3. Exercise 3 was performed in 10 repetitions by lifting the toes and rotating the feet at the ankle sideways in a 360-degree motion.
4. Exercise 4 was performed in 10 repetitions by lifting both heels, rotating both heels sideways, lowering them back to the floor, and moving them toward the center.
5. Exercise 5 was performed in 10 repetitions by lifting one knee, straightening the leg, moving the toes forward, lowering the leg back down, and alternating between the left and right legs.
6. Exercise 6 was performed in 10 repetitions by straightening one leg on the floor, lifting the leg, moving the toes toward the face, and lowering the heel back to the floor.
7. Exercise 7 was performed in 10 repetitions by lifting both legs, straightening and maintaining the position, then moving the feet at the ankles forward and backward.
8. Exercise 8 was performed in 10 repetitions by straightening and lifting one leg, then rotating the foot at the ankle.
9. Exercise 9 was performed using a sheet of newspaper. The patient folded the newspaper using the feet into a ball-like shape, unfolded it again using both feet, and then tore it into pieces. The torn pieces were then collected using both feet, placed on another sheet of newspaper, and wrapped using both feet.

Insulin Therapy

In this study, insulin therapy was administered as part of the combined intervention with diabetic foot exercises in a patient with type 2 diabetes mellitus. The types of insulin used were insulin glargine (Lantus) and insulin glulisine (Apidra), according to the patient's prescribed medical regimen. Insulin glargine is a long-acting insulin used as basal insulin to maintain blood glucose stability for 24 hours. Meanwhile, insulin glulisine is a rapid-acting insulin administered before meals to control postprandial blood glucose elevation.

Before insulin administration, the researcher assessed the patient's general condition, including random blood glucose levels, upper and lower extremity blood pressure, and Ankle Brachial Index (ABI) values. Blood glucose examination was performed using a glucometer as pre-test data. The insulin administration procedure was performed through the following steps:

1. Preparing the equipment and materials, including an insulin pen, insulin needle, alcohol swabs, and clean gloves.
2. Washing hands according to hand hygiene procedures.
3. Measuring blood glucose levels before insulin administration.

4. Preparing the insulin dose according to the physician's instructions, namely Apidra 6 units before meals and Lantus 8 units before bedtime.
5. Selecting a subcutaneous injection site, such as the abdomen, thigh, or upper arm.
6. Cleaning the injection site using an alcohol swab.
7. Injecting insulin subcutaneously at a 45–90-degree angle according to the thickness of the patient's subcutaneous fat tissue.
8. After Apidra insulin injection, the patient was instructed to eat immediately.

The combined intervention of insulin therapy and diabetic foot exercises was performed for seven consecutive days with daily monitoring of changes in blood glucose levels and peripheral perfusion in the patient.

RESULTS AND DISCUSSION

The seven-day foot exercise intervention showed improvement in blood glucose levels and Ankle Brachial Index (ABI) values. Changes in daily ABI values and blood glucose levels during the intervention are presented in the following table.

Table 1. Measurement of Blood Glucose Levels and ABI Values Before and After the Intervention

Day	Foot Systolic Pressure (mmHg) Pre	Foot Systolic Pressure (mmHg) Post	Arm Systolic Pressure (mmHg) Pre	Arm Systolic Pressure (mmHg) Post	ABI Pre	ABI Post	ABI Interpretation	Blood Glucose Level (mg/dL) Pre	Blood Glucose Level (mg/dL) Post
1	92	94	118	118	0.77	0.79	Mild PAD	226	215
2	93	95	118	118	0.78	0.80	Mild PAD	214	205
3	94	95	119	120	0.78	0.79	Mild PAD	200	190
4	94	96	114	114	0.82	0.84	Mild PAD	195	182
5	94	98	118	120	0.79	0.81	Mild PAD	187	177
6	96	98	116	118	0.82	0.83	Mild PAD	183	171
7	98	98	116	112	0.84	0.87	Mild PAD	195	169

Source: Primary Data, 2026

The findings showed that the combination of insulin therapy and diabetic foot exercises in a patient with type 2 diabetes mellitus contributed to a decrease in blood glucose levels and an increase in Ankle Brachial Index (ABI) values. On the first day, the blood glucose level decreased from 226 mg/dL to 215 mg/dL, accompanied by an increase in ABI from 0.77 to 0.79. On the second day, the blood glucose level decreased from 214 mg/dL to 205 mg/dL, while the ABI increased from 0.78 to 0.80. On the third day, the blood glucose level decreased from 200 mg/dL to 190 mg/dL, with an increase in ABI from 0.78 to 0.79. On the fourth day, the blood glucose level decreased from 195 mg/dL to 182 mg/dL, while the ABI increased from 0.82 to 0.84. On the fifth day, the blood glucose level decreased from 187 mg/dL to 177 mg/dL, accompanied by an increase in ABI from 0.79 to 0.81. On the sixth day, the blood glucose level decreased from 183 mg/dL to 171 mg/dL, with an increase in ABI from 0.82 to 0.83. On the seventh day, the blood glucose level decreased from 195 mg/dL to 169 mg/dL, while the ABI increased from 0.84 to 0.87. Overall, there was a decrease in blood glucose level from 226 mg/dL to 169 mg/dL and an increase in ABI from 0.77 to 0.87 after seven days of combined insulin therapy and diabetic foot exercises.

Based on the seven-day measurement results, the patient's blood glucose level gradually decreased from 226 mg/dL on the first day to 169 mg/dL on the seventh day after the implementation of combined insulin therapy and diabetic foot exercises. The decrease in blood glucose levels in this study was relatively consistent, beginning from 226 mg/dL to 215 mg/dL on the first day and continuing to decline until reaching 169 mg/dL on the seventh day. Insulin therapy plays a direct role in increasing glucose transport into cells, thereby reducing blood glucose levels. Meanwhile, diabetic foot exercises increase glucose utilization by the muscles as an energy source. When both interventions are provided simultaneously, the effectiveness of glucose metabolism may improve, allowing blood glucose levels to decrease more

optimally than with insulin therapy alone. The reduction in blood glucose levels in this study can be explained through the physiological mechanism of muscle activity during foot exercises. Muscle contraction increases glucose uptake by muscle cells through the activation of glucose transporter type 4 (GLUT-4), allowing more circulating glucose to be used for energy production. In addition, physical activity increases the sensitivity of insulin receptors, allowing administered insulin to work more effectively in controlling blood glucose levels. This condition supports better glycemic control in patients with type 2 diabetes mellitus (Schleicher et al., 2022).

The findings of this study are consistent with the study by Astuti and Hartutik (2023), which showed that diabetic foot exercises could reduce blood glucose levels in patients with type 2 diabetes mellitus. The study explained that regular physical exercise can help control blood glucose levels by increasing glucose metabolism in muscle tissue. The reduction in blood glucose levels indicates that simple physical activity, such as diabetic foot exercises, can serve as an effective supportive therapy in diabetes management. These findings are also supported by Rahmalena and Andari (2023), who found a decrease in postprandial blood glucose levels after the implementation of diabetic foot exercises. The average blood glucose level of respondents decreased after the intervention, with statistical analysis showing a p-value of 0.001, indicating a significant effect of diabetic foot exercises on reducing blood glucose levels. The study emphasized that muscle activity in the lower extremities can increase glucose utilization, thereby helping to improve blood glucose control.

In addition, the Ankle Brachial Index (ABI) value also increased from 0.77 to 0.87. This result indicates improved glycemic control as well as enhanced peripheral perfusion in the lower extremities. Type 2 diabetes mellitus is a chronic metabolic disease characterized by insulin resistance and impaired insulin secretion, leading to persistent hyperglycemia. These findings support the hypothesis that diabetic foot exercises may be effective in reducing blood glucose levels through increased muscle activity and improved peripheral circulation (Amaravadi et al., 2024). The results of this study are in line with the findings of Rudini et al. (2026), which stated that diabetic foot exercises are effective in improving peripheral blood circulation, strengthening small foot muscles, and reducing blood glucose levels in patients with diabetes mellitus.

Light physical exercise, such as diabetic foot exercise, can improve insulin sensitivity and glucose metabolism. The same study explained that diabetic foot exercises help stimulate peripheral nerves and improve blood flow, allowing glucose to be utilized more optimally by body cells and reducing blood glucose levels (Novaković-Bursać et al., 2024).

The researchers concluded that diabetic foot exercise is one of the non-pharmacological interventions that can improve peripheral blood circulation. The improvement in ABI values observed in this study may also have been influenced by the reduction in blood glucose levels. When blood glucose levels decrease, endothelial damage caused by hyperglycemia may be reduced, resulting in better vascular function. Lower blood glucose levels may also reduce blood viscosity and improve tissue microcirculation. Thus, the combination of insulin therapy and diabetic foot exercises provides dual benefits, namely improving glucose metabolism and increasing peripheral perfusion. From a nursing perspective, the findings of this study indicate that diabetic foot exercises can be used as a complementary intervention to insulin therapy to address impaired peripheral perfusion in patients with type 2 diabetes mellitus. This intervention is relatively easy to perform, low-cost, safe for patients, and can be taught as part of a home-based self-care program. The increase in ABI values indicates that diabetic foot exercises may help reduce the risk of chronic complications, such as peripheral arterial disease, diabetic foot ulcers, gangrene, and lower-extremity amputation.

However, this study has limitations because it involved only one subject and had a short intervention duration of seven days; therefore, the findings cannot be generalized. Further studies involving larger sample sizes and longer intervention periods are highly recommended to provide more comprehensive evidence regarding the effectiveness of combined insulin therapy and diabetic foot exercises in reducing blood glucose levels.

CONCLUSION

Based on the findings and discussion, it can be concluded that the combination of insulin therapy and diabetic foot exercises had a positive effect on blood glucose control and improvement of peripheral

perfusion in a patient with type 2 diabetes mellitus. The measurement results showed a gradual decrease in blood glucose levels from 226 mg/dL on the first day to 169 mg/dL on the seventh day after the intervention. In addition, the Ankle Brachial Index (ABI) value increased from 0.77 to 0.87, indicating improved peripheral blood circulation in the lower extremities. This increase in ABI value indicates that diabetic foot exercises may improve tissue perfusion through the mechanism of lower-limb muscle contraction, which functions as a muscle pump, thereby facilitating blood flow to the lower extremities. Improvement in peripheral perfusion is important for patients with type 2 diabetes mellitus because it may reduce the risk of peripheral arterial disease, diabetic neuropathy, diabetic foot ulcers, and amputation. Therefore, the combination of insulin therapy and diabetic foot exercises can be recommended as a complementary intervention that is easy to implement, safe, economical, and effective in supporting the holistic management of type 2 diabetes mellitus.

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