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COMBINATION OF FOOT MASSAGE AND ACTIVE RANGE OF MOTION IN NURSING CARE FOR DIABETIC NEUROPATHY PATIENTS WITH INEFFECTIVE PERIPHERAL PERFUSION: A CASE STUDY

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ABSTRACT

Diabetic neuropathy is one of the most common chronic complications found in patients with type 2 diabetes mellitus, characterized by decreased foot sensitivity and impaired peripheral circulation. A frequently encountered nursing problem is ineffective peripheral perfusion, which increases the risk of diabetic foot ulcers and amputation. Non-pharmacological interventions such as foot massage and active range of motion (ROM) exercises have been proven effective in enhancing peripheral perfusion and sensory function. This study aims to explore the implementation of a combination of foot massage and active ROM exercises in improving sensitivity and peripheral circulation in patients with diabetic neuropathy. A case study design was used, employing a nursing care approach based on Evidence-Based Nursing (EBN). The therapy was administered over three consecutive days, consisting of a 25–30-minute foot massage followed by approximately 30 minutes of active ROM exercises each morning. Evaluation was conducted using the Toronto Clinical Neuropathy Score (TCNS) and Ankle Brachial Index (ABI) screening with Doppler ultrasound before and after the intervention. The results showed a decrease in TCNS score from 12 (severe neuropathy) on the first day to 6 (mild neuropathy) on the third day. ABI values increased from 0.30 (severe) to 0.71 (mild). Improvements were also observed in capillary refill time, skin color, reduced edema, and decreased paresthesia. In conclusion, the combination of foot massage and active ROM exercises effectively improved sensitivity and peripheral circulation in patients with diabetic neuropathy, thereby supporting conventional therapies provided during hospital care.

Keywords: *Foot massage, Active ROM exercise, Diabetic neuropathy, Sensitivity, Peripheral circulation*

INTRODUCTION

Type 2 diabetes mellitus (DM) is a chronic metabolic disease characterized by elevated blood glucose levels due to insulin secretion or action disorders. Prolonged and continuously increasing blood glucose levels can result in various complications (Made et al., 2025). One of the most common long-term complications in type 2 DM patients is diabetic neuropathy, which refers to nerve damage due to persistently high blood glucose levels. Neuropathy primarily affects peripheral nerves, especially in the lower extremities, leading to reduced foot sensitivity, tingling, numbness, and loss of pain perception (Al-Fahham & Al-Jubouri, 2024). This complication is dangerous and can progress to diabetic foot ulcers, which may eventually require amputation if not properly (Lepesis, Paton, et al., 2023).

The global prevalence of type 2 diabetes continues to rise annually (Guo et al., 2020). According to the International Diabetes Federation (IDF), approximately 10.5% of the global adult population had diabetes in 2021, with Indonesia ranking fifth with 19.5 million cases. Neuropathy is a common complication, affecting nearly 50% of people with diabetes (Jiang et al., 2023), with global prevalence ranging between 60–70% (IDF, 2022). In Indonesia, 28% of type 2 DM patients experience microvascular complications including nephropathy (7.7%), neuropathy (17.6%), and retinopathy (2.7%), while 16.8% experience macrovascular complications (IDF, 2021). Data from an inpatient unit in a hospital in Jember revealed two patients diagnosed with type 2 DM and accompanying neuropathy complications.

Peripheral nerve damage in type 2 DM is caused by prolonged microcirculatory disturbances, resulting in reduced oxygen and nutrient supply to peripheral tissues and leading to nerve fiber degeneration. This condition reduces vascular elasticity and impairs nerve impulse conduction. To break the pathological cycle, interventions are needed to improve peripheral perfusion and stimulate sensory nerve recovery (Lepesis, Paton, et al., 2023). Foot massage is a non-pharmacological therapy that involves gentle pressure on the foot to stimulate skin mechanoreceptors, trigger local vasodilation, enhance blood flow, and promote the release of neurotrophic factors that support nerve (Lepesis, Marsden, et al., 2023); (Made et al., 2025). On the other hand, active range of motion (ROM) exercises involve voluntary muscle contractions that can improve peripheral circulation, enhance local metabolism, and facilitate glucose uptake by muscles independent of insulin (Suza et al., 2020). These two interventions have a strong physiological basis for addressing impaired peripheral perfusion and sensory deficits caused by diabetic neuropathy.

To date, pharmacological therapy for type 2 DM patients has mainly focused on blood glucose control, which has not effectively

addressed nerve damage or peripheral blood flow. Thus, a non-pharmacological approach that is effective, safe, and affordable is needed. The combination of foot massage and active ROM exercises has shown synergistic effects in increasing peripheral blood flow, improving foot sensitivity, and preventing diabetic foot ulcers (Lepesis, Marsden, et al., 2023); (Made et al., 2025). This combined intervention can be implemented to enhance peripheral perfusion and prevent more serious complications (Al-Fahham & Al-Jubouri, 2024). Based on this, the present case study was conducted to examine the implementation of a combination of foot massage and active ROM exercises in improving sensitivity and peripheral perfusion in patients with diabetic neuropathy.

CASE REPORT

The patient, Mrs. S, is a 47-year-old self-employed woman with a history of type 2 diabetes mellitus and hypertension for the past five years, as well as stage 5 chronic kidney disease (CKD) diagnosed one year prior. She was admitted to a hospital in Jember due to complaints of tingling, numbness, and stabbing pain in both lower limbs, which had persisted for two weeks and worsened a day before admission. These symptoms were accompanied by swelling in the hands and feet and a decrease in consciousness due to hypoglycemia, with a random blood glucose level of 45 mg/dL upon arrival at the emergency department. Prior to admission, the patient had experienced severe hyperglycemia (blood glucose up to 500 mg/dL) and had attempted a strict diet, which exacerbated her condition and triggered hypoglycemia. After stabilization and transfer to the inpatient ward, the patient continued to exhibit signs of decreased sensory function in the lower extremities. The condition of the patient's feet is presented in Figure 1.

Figure 1 Illustrates the condition of the patient's lower extremities

Physical examination revealed that the lower limbs appeared pale and cold, with a capillary refill time of more than 3 seconds and weak dorsalis pedis pulses. There was a marked reduction in tactile and vibration sensitivity. The Toronto Clinical Neuropathy Score (TCNS) was recorded at 12, indicating severe diabetic neuropathy, while the Ankle-Brachial Index (ABI) was 0.30, indicating severe peripheral perfusion impairment. On the third day of hospitalization, her RBG was 219 mg/dL, blood pressure was 209/100 mmHg, and hemoglobin level was 9.8 g/dL. The patient appeared lethargic, frequently drowsy, and exhibited signs of dehydration such as decreased skin turgor. Based on these findings, the primary nursing diagnosis was ineffective peripheral perfusion.

Management involved a combination of pharmacological and non-pharmacological therapies. Pharmacological treatments included D10% infusion (7 drops/min), 3% NaCl, ceftriaxone 2×1 g every 16 hours, furosemide 20 mg every 8 hours, ondansetron 4 mg every 8 hours, lansoprazole 30 mg every 24 hours, vitamin B complex, folic acid, bisoprolol 2.5 mg every 24 hours, nicardipine 0.5 mg/hour, and sodium bicarbonate 500 mg every 8 hours.

Clinical evaluation showed significant improvement. On the first day following the intervention, the TCNS score decreased to 10, and the ABI increased to 0.38, indicating the beginning of circulatory improvement. On the second day, the TCNS score dropped to 8, and the ABI rose to 0.54. The patient reported decreased numbness and pain, and an increased sense of warmth and comfort in the feet. On the third day, the TCNS score further declined to 6, and the ABI increased to 0.71. Capillary refill time improved to less than 2 seconds, peripheral pulses became stronger, and the extremities felt warmer. The patient also appeared more energetic, with improved activity tolerance and a more stable gait.

These results indicate that the combination of foot massage and active ROM exercises, alongside conventional therapies administered during hospitalization, was effective in enhancing peripheral perfusion and sensory function in a patient with diabetic neuropathy. This therapy can be safely and affordably applied in clinical nursing practice.

RESEARCH METHOD

This case study applied an Evidence-Based Nursing (EBN) approach to examine the effectiveness of foot massage and active Range of Motion (ROM) exercises in improving sensitivity and peripheral circulation in a patient with diabetic neuropathy. The subject was Mrs. S, a hospitalized patient diagnosed with type 2 diabetes mellitus with neuropathic complications at a regional hospital in Jember. She met the inclusion criteria were (1) willingness to participate as evidenced by signed informed consent, (2) ability to communicate effectively and follow simple instructions, and (3) stable hemodynamic status. The exclusion criteria were: (1) patients with open wounds or active ulcers on the feet, (2) patients with severe musculoskeletal disorders that limited lower limb mobility, and (3) patients with unstable vital signs during the intervention period.

The intervention was administered over three consecutive days in June 2025. Each session consisted of a 25–30-minute foot massage followed by approximately 30 minutes of active ROM exercises. Meanwhile, the non-pharmacological nursing intervention involved a combination of foot massage and active Range of Motion (ROM) exercises administered once daily in the morning for three consecutive days. The massage involved applying gentle pressure to the lower legs, ankles, soles, and toes, using the thumbs in a stepwise technique. The

ROM exercises included flexion-extension, adduction-abduction of the hips and toes, knee flexion-extension, ankle dorsiflexion and plantar flexion, and foot inversion-eversion movements.

The foot massage was performed manually by the researcher using techniques adapted from basic Swedish massage principles, specifically effleurage and petrissage. Effleurage involved long, rhythmic strokes from the toes toward the ankle to stimulate circulation and relaxation, while petrissage included gentle pulling and pressing of the toes, ankle rotations, toe slides, and firm pressure applied to the arch of the foot (arch press) to activate soft tissue and enhance peripheral perfusion. Olive oil was used to ease hand movements and increase comfort.

The ROM exercises were conducted independently by the patient under supervision. The exercises aimed to maintain joint flexibility, improve peripheral blood flow, and stimulate neurosensory function. Movements included flexion and extension of the knees, dorsiflexion and plantarflexion of the ankles, inversion and eversion of the feet, and toe flexion-extension. Each motion was repeated 3–5 times according to the patient's capacity, with total exercise duration of approximately 30 minutes per session. The patient performed the exercises in a seated or supine position for safety and comfort, with responses such as pain, fatigue, or swelling monitored closely.

Outcome measures included the Toronto Clinical Neuropathy Score (TCNS) to assess sensory function (Bril et al., 2009; Al-Fahham & Al-Jubouri, 2024) and the Ankle-Brachial Index (ABI) to evaluate peripheral circulation (National Library of Medicine, 2023), both measured before and after the intervention. Descriptive analysis was applied. In addition, this intervention was integrated within a comprehensive nursing care plan addressing the patient's primary nursing diagnosis of ineffective peripheral perfusion and was implemented by the researcher as part of structured clinical nursing care.

This research was conducted with the approval, permission, and direction of the hospital's nursing education and training unit as part of the final nursing research project. The research was conducted under the supervision and guidance of hospital nurses and academic lecturers. Throughout the study, the principles of informed consent, confidentiality, fairness, and beneficence were upheld.

Interpretation of the results should consider several potential confounding factors. The patient was receiving multiple pharmacological therapies, including antihypertensives, antibiotics, and diuretics, which may have influenced peripheral perfusion and sensory function. In addition, the presence of comorbidities such as chronic kidney disease and hypertension could have affected vascular response to the intervention. These confounding factors need to be taken into account

when attributing clinical improvements solely to the combination of foot massage and active range of motion exercises.

RESULTS

The foot massage and active ROM interventions were carried out for three consecutive days with daily monitoring of outcomes. Changes in the Toronto Clinical Neuropathy Score (TCNS) were recorded to evaluate the effectiveness of the intervention on sensitivity, while Ankle-Brachial Index (ABI) values were recorded to assess improvements in peripheral circulation. The results showed progressive clinical improvement.

Table 1. Results of the combined foot massage and active ROM interventions on foot sensitivity based on TCNS score

		The combined foot massage and active ROM interventions	
		Pre-Intervention (Sensitivity)	***Post-Intervention (Sensitivity)***
No	Date		
1	June 18, 2025	TCNS Score: 12	TCNS Score: 10
2	June 19, 2025	TCNS Score: 10	TCNS Score: 8
3	June 20, 2025	TCNS Score: 7	TCNS Score: 6

Based on TCNS, the results indicate a steady improvement in sensitivity from the first to the third day of intervention :

Day 1 (June 18, 2025)

Before the intervention, the patient's TCNS score was 12, indicating moderate to severe neuropathy. After the combined intervention of foot massage and active ROM exercises, the score dropped to 10. This decrease was primarily observed in the sensory symptoms component, where the patient reported reduced pain and numbness. Knee reflexes also improved. Sensory testing revealed the patient could detect temperature, and monofilament/pinprick tests showed sensation in 5 out of 10 points—indicating an initial positive response.

Day 2 (June 19, 2025)

The pre-intervention TCNS score was 10, decreasing to 8 afterward. Improvement was noted in sensory symptoms, with reduced numbness and pain. The patient retained the ability to detect temperature, and touch and position perception improved. These findings suggest a progressive therapeutic effect, particularly on sensory function.

Day 3 (June 20, 2025)

The TCNS score decreased from 7 to 6 after therapy. The most notable improvements were in the reduction of tingling, numbness, and pain. Reflexes, especially ankle reflexes, improved, and the patient could detect temperature, light touch, and position. The monofilament/pinprick test showed sensation at 8 out of 10 points. With a TCNS score of 6, the patient's neuropathy was categorized as mild, indicating significant improvement over a short period.

Table 2. Results of the combined foot massage and active ROM interventions on peripheral circulation based on ABI score

No	Date	The combined foot massage and active ROM interventions	
		Pre-Intervention (ABI)	***Post-Intervention (ABI)***
1	June 18, 2025	ABI:0,30	ABI:0,38
2	June 19, 2025	ABI: 0,42	ABI:0,54
3	June 20, 2025	ABI:0,60	ABI: 0,71

Based on ABI values, the results indicate a steady improvement in peripheral circulation from the first to the third day of intervention. On the first day, the pre-intervention ABI score was 0.30, indicating severe impairment. After the intervention, the ABI slightly improved to 0.38. On the second day, the ABI increased from 0.42 (severe) to 0.54 (moderate). On the third day, a significant improvement was observed, with ABI increasing from 0.60 (moderate) to 0.71 (mild). This demonstrates improved blood flow to the lower extremities.

Table 3. Outcomes of Combined Foot Massage and Active ROM Therapy on Peripheral Perfusion Nursing Indicators

Date	Capillary Refill Time	Skin Color of Extremities	Peripheral Pulse Strength	Peripheral Edema
June 18, 2025	>3 seconds	Pale and cold	Weak	+3 (moderate)
June 19, 2025	3 seconds (moderate)	Slightly reddish, warm	Moderate	+3 (moderate)
June 20, 2025	<3 seconds (normal)	Pink and warm	Strong	+2 (mild)

Over the course of three days of combined foot massage and active ROM intervention, peripheral perfusion indicators demonstrated progressive improvement. On Day 1, CRT was >3 seconds, skin appeared pale and cold, peripheral pulses were weak, and pitting edema was noted at +3. On Day 2, CRT improved to 3 seconds, skin became warmer and slightly reddish, peripheral pulses increased to moderate, while edema remained at +3. On Day 3, CRT improved further to <3 seconds (within normal range), skin became pink and warm, pulse strength increased to strong, and edema reduced to +2. Full details are presented in Table 3.

DISCUSSION

The implemented intervention involved administering foot massage and active ROM exercises for 25–30 minutes over three consecutive days to patient Mrs. S. The Toronto Clinical Neuropathy Score (TCNS) and Ankle-Brachial Index (ABI) were assessed pre- and post-intervention, with baseline measurements taken 15 minutes prior and follow-up assessments 15 minutes after each session.

Progress in TCNS Scores for Foot Sensitivity

Neurological and sensory function assessment using TCNS demonstrated a consistent decline in scores, from 12 on the first day to 10 on the second day, and eventually to 6 on the third day. This reduction indicated significant improvement in peripheral nerve sensitivity,

physiological reflexes, and sensory perception.

On day one (June 18, 2025), the patient initially experienced symptoms of numbness, tingling, and impaired positional sense and reflexes. A TCNS score of 12 indicated moderate to severe neuropathy. Following the intervention, the score decreased to 10, accompanied by reduced numbness, improved positional awareness, and enhanced knee reflex. Temperature sensation remained intact, while monofilament response was detected at only 5 out of 10 points. The patient began reporting a lighter and more comfortable sensation in the feet, although numbness was still present. These results align with Chatchawan et al. (2020) who found that foot massage enhances local blood flow and alleviates pain and numbness in diabetic neuropathy patients.

On day two (June 19, 2025), the TCNS score decreased to 8, showing continued sensory improvement, especially in light touch and positional perception. Tingling was no longer present, and temperature recognition was preserved. Reflexes remained partially impaired but stable. According to Chatchawan et al. (2020), foot massage and active ROM exercises improve sensory function by activating mechanoreceptors and microcirculation, promoting sensory nerve regeneration. Al-Fahham & Al-Jubouri (2024), further noted that the combination therapy activates peripheral nerves and increases vascular elasticity, facilitating faster circulation recovery.

On day three (June 20, 2025), results improved markedly, with the TCNS score falling to 6. The patient no longer experienced tingling or numbness, ankle reflexes improved, and touch, temperature, and position perception normalized. Monofilament detection improved from 5 to 8 out of 10 points.

Physiologically, foot massage stimulates mechanoreceptors located in the skin and soft tissues of the foot that respond to touch, pressure, and vibration. In patients with neuropathy, these receptors are often damaged due to chronic hyperglycemia. Gentle rhythmic pressure over 25–30 minutes activates these receptors, sending impulses to the central nervous system and triggering parasympathetic responses that promote relaxation and nerve regeneration (Chatchawan et al., (2020); Cicek et al., (2021).

Meanwhile, active ROM exercises performed for 30 minutes involve conscious joint movement by the patient, activating proprioceptors located in muscles and joints, which inform the brain of body position, pressure, and direction. This sensory stimulation helps reduce paresthesia symptoms such as tingling and numbness. Voluntary movement also strengthens the neuromuscular system, enhancing sensory awareness of pressure and position (Lepesis, Paton, et al., 2023).

The combination of foot massage and ROM exercises stimulates both tactile and proprioceptive sensory pathways,

producing a synergistic effect on peripheral nerve conduction. Maeshige et al. (2023) reported that combined physical and motor stimulation significantly improved nerve function within days. This is consistent with studies by Al-Fahham & Al-Jubouri (2024) and Made et al. (2025), which found significant improvements in foot sensitivity after two weeks and even one week of consistent combined therapy.

Progress in ABI Values for Peripheral Circulation

In addition to sensory improvements, enhancements in peripheral perfusion were also evident through ABI examination. The patient's ABI increased from 0.30 before the intervention to 0.38 on the first day, then to 0.54 on the second day, and finally reached 0.71 on the third day. This progression indicates a gradual recovery from severe ischemia to near-normal peripheral blood flow.

On the first day, an ABI improvement from 0.30 to 0.38 indicated the beginning of circulatory recovery. Foot massage stimulated local vasodilation, while active ROM exercises supported the calf muscle pump mechanism, enhancing venous return. Chatchawan et al. (2020) noted that this technique improves microcirculation and reduces peripheral resistance.

On the second day, ABI rose significantly to 0.54 (moderate). The patient reported a warming sensation and lighter feeling in the feet. Al-Fahham & Al-Jubouri (2024) highlighted that this combination intervention enhances vascular elasticity and accelerates peripheral vascular recovery.

The third day showed continued improvement with ABI reaching 0.71—approaching the threshold of normal circulation. Made et al. (2025) emphasized that improved perfusion plays a crucial role in healing neuropathy, as peripheral nerves rely heavily on oxygen and nutrient supply for regeneration.

Physiologically, foot massage activates baroreceptors located in blood vessel walls that respond to pressure changes. Gentle stimulation for 25–30 minutes induces vasodilation, increasing blood flow through the capillaries. This reflex effect raises skin temperature, speeds up capillary refill, and improves skin color and moisture in the lower limbs (Chatchawan et al., 2020);(Cicek et al., 2021).

Active ROM exercises contribute to improved circulation as actively contracting muscles compress blood vessels, facilitating venous return to the heart. These movements also enhance arterial flow to the feet, allowing tissues to receive oxygen and nutrients more efficiently. This process, known as the muscle pump effect, is essential in peripheral circulation physiology (Made et al., 2025).

The combination of foot massage and active ROM provides a synergistic effect: foot massage enhances superficial blood flow via autonomic reflexes, while ROM boosts systemic circulation through muscle activity. When administered together, they promote a more

comprehensive and effective blood flow to the lower limbs (Chatchawan et al., 2020). Made et al. (2025) onfirmed that this combined therapy significantly increased ABI and reduced neuropathic symptoms within two weeks, with visible improvements already observed by the first week. These findings underscore the effectiveness of the combination in improving peripheral circulation (Al-Fahham & Al-Jubouri, 2024).

Changes in Nursing Outcome Indicators: Peripheral Perfusion

The observed improvements were not limited to ABI values and TCNS score reductions, but also involved clinical indicators such as stronger peripheral pulses, reduced edema, improved skin coloration, and faster capillary refill time. On the first day, the patient presented with CRT >3 seconds, pale and cold feet, very weak dorsalis pedis pulses, and +3 pitting edema—signs indicative of significant peripheral circulatory compromise.

Following the implementation of combined foot massage and active ROM exercises, clinical signs began to improve by Day 2. CRT improved to 3 seconds, the skin appeared warmer and slightly reddish, pulse strength increased to moderate, although edema remained unchanged. These findings are consistent with Solmaz (2023), who reported that foot massage stimulates venous and lymphatic flow, promotes interstitial fluid reabsorption, and reduces tissue pressure. By Day 3, CRT improved to <3 seconds, skin became pink and warm, peripheral pulses became strong, and edema decreased to +2. These findings are further supported by Souza Silva (2021), who stated that active ROM exercises such as dorsiflexion and plantarflexion enhance calf muscle pump function, facilitating venous return and reducing fluid stasis in the lower limbs.

All indicators showed significant improvement within the three-day intervention period. The combination of foot massage and active ROM proved effective in enhancing peripheral perfusion in diabetic neuropathy patients by stimulating blood and lymphatic circulation. Improvements were evident across both objective parameters (CRT, skin color, pulse, edema) and subjective symptoms.

The combined intervention of foot massage and active ROM was proven effective in improving peripheral circulation and sensory nerve function in patients with diabetic neuropathy. With consistent application, proper technique, and adequate duration, this therapy produces peripheral Perfusion significant improvements both clinically and objectively. Hence, it is a promising non-pharmacological nursing strategy for managing diabetic neuropathy.

The effectiveness of this intervention is further optimized when integrated with conventional therapies such as glycemic control, blood pressure management, and neurotropic vitamin supplementation (e.g., vitamin B complex and folic acid). A multidisciplinary approach

that combines pharmacological and nursing non-pharmacological interventions facilitates faster and more comprehensive recovery of nerve function and circulation. The synergy between these approaches provides a safe, effective, and sustainable strategy to improve the quality of life for diabetic patients suffering from peripheral neuropathy care.

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STUDY LIMITATIONS

This case study has several limitations. First, the single-case design inherently limits the generalization of the findings to broader patient populations. Second, the patient was simultaneously receiving multiple pharmacological therapies including antihypertensives, antibiotics, and diuretic, which may have influenced peripheral perfusion and neuropathic symptoms. The presence of comorbidities such as hypertension and chronic kidney disease also acted as confounding factors that complicated the interpretation of outcomes. Third, patient adherence to diet and prescribed medications may have further affected clinical improvements. Finally, the absence of a control group restricts the ability to establish a causal relationship between the combined interventions of foot massage and active range of motion exercises and the observed improvements. Future studies with larger sample sizes and controlled designs are recommended to validate these findings.

CONCLUSION

The combination of foot massage and active ROM exercises was proven effective in improving sensitivity and peripheral circulation in patients with diabetic neuropathy, as indicated by a decrease in TCNS scores and an increase in ABI values. This intervention can be implemented as an independent nursing action to prevent further complications such as diabetic foot ulcers and amputation.

RECOMMENDATIONS

This intervention is recommended to be integrated into the standard care protocols for patients with diabetic neuropathy in healthcare facilities. Further research using experimental designs is encouraged to strengthen the scientific evidence of its effectiveness.

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