

The Effect of Range of Motion (ROM) Exercises on Sensory Function and Ankle Brachial Index in Diabetes Mellitus Patients at Tamamaung Health Center, Makassar

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Abstract. The problem that often occurs in Diabetes Mellitus is peripheral neuropathy. Peripheral neuropathy can cause sensory sensations in the legs to decrease or even disappear. Flow disturbances in the legs could be detected by measuring the ankle brachial index (ABI), which measures the ratio of the systolic pressure in the arm to the systolic pressure of the lower leg. One of non-pharmacological therapy is lower range of motion (ROM).

This study aimed to determine whether there is an effect of Range of Motion (ROM) exercise on sensory function and Ankle brachial Index in DM patients. This study was conducted in Tamamaung Health Center, Makassar. It used pre-experimental research method in the form of one-group pretest-posttest design. It was conducted with direct observation by the researchers. The research sample was 15 respondents at Tamamaung Health Center Makassar who met the criteria of inclusion. Analysis of the data used Wilcoxon Signed Ranks test and Paired Sample T-Test. Results of sufficient analysis showed the effect of range of motion exercise on the sensory function and Ankle brachial index in DM patients at Tamamaung Health Center, Makassar. The sensory function was tested using Wilcoxon Signed Ranks test and obtained the value of $\rho = 0.001$, indicating that value of ρ was smaller than $\alpha = 0.05$. Thus, for the sensory function, H_a was accepted and H_0 was rejected. In addition, the right ABI value was tested using Wilcoxon Signed Ranks Test and obtained the value of $\rho = 0.001$. In contrast, the left ABI value wastested using the Paired Sample T Test and obtained the value of $\rho = 0.000$, indicating that the value of ρ was smaller than $\alpha = 0.05$. It means that for ABI value, H_a was accepted and H_0 was rejected. The results concludes that there is an effect of range of motion exercise on sensory function and Ankle brachial index in diabetes mellitus patients at Tamamaung Health Center, Makassar. It is recommended that there should be educational program and implementation of ROM exercises especially in diabetes mellitus patients.

Keywords: Ankle Brachial Index; Range of Motion; Diabetes Mellitus

1. Introduction

Due to its continuously increasing prevalence, Diabetes Mellitus (DM) is a disease that has received global attention. Based on data from the International Diabetes Federation (2015), there were 387 million DM patients in 2014, which increased to 415 million DM patients in 2015 and is estimated to increase to 642 million patients by 2040 [1].

WHO (2018) affirmed that the global prevalence of diabetes mellitus in adults over 18 has increased from 4.7% in 1980 to 8.5% in 2014. Based on this number, Indonesia ranks fifth in the world. A report from the Health Research and Development Agency (Balitbangkes) with the results of Basic Health Research (RISKESDAS) in 2013 demonstrated that there was an increase in the prevalence of diabetes mellitus patients obtained from interviews; 1.1% in 2007 to 1.5% in 2013.

Moreover, based on the doctor's diagnosis or symptoms, the prevalence of diabetes mellitus was [2]. 1% in 2013, with the highest prevalence of doctor diagnosis results found in the Central Sulawesi area (3, 7%). The lowest was in West Java (0.5%), while the prevalence of diabetes patients in North Sulawesi reached 2.4% [3]. Referring to the data from RISKESDAS (2018), there was an increase in the prevalence of diabetes mellitus patients from 6.9 in 2013 to 8.5% in 2018 [4].

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia due to abnormalities in insulin secretion, insulin action, or both [5]. The problem that often occurs in DM

patients is peripheral neuropathy, with a prevalence between 22.7% and 54.0%. Peripheral neuropathy is a sign or symptom of peripheral nerve dysfunction in people with diabetes. It is estimated that 37% to 45% of type 2 diabetes patients and 54-59% of type 1 diabetes patients have peripheral neuropathy [6]. The prevalence of peripheral neuropathy in DM patients admitted to Dr. Cipto Mangunkusumo Hospital Jakarta in 2011 reached 54%. This complication is a type of complication that is mostly experienced by treated DM patients. Peripheral neuropathy can cause sensory sensations in the legs to decrease or even disappear. The decreased sensation results in the patient being unable to control the trauma, so the patient is prone to leg injuries [7].

Furthermore, poor circulation in the legs can be detected by measuring the ankle-brachial index (ABI), which measures the ratio of the systolic pressure in the arm to the systolic pressure of the lower leg. Ankle Brachial Index (ABI) is a non-invasive examination of blood vessels that functions to detect clinical signs and symptoms of ischemia and decreased peripheral function that can lead to angiopathy and diabetic neuropathy. ABI measurement results show the state of blood circulation in the lower limbs with a value range of 0.90-1.2, indicating that the circulation to the leg area is normal. This value is obtained from comparing systolic pressure in the area of the feet and hands [8].

Numerous studies have developed various interventions to prevent or slow the onset of sensory neuropathy. One of the interventions studied is the effect of physical exercise (foot exercise) on the effectiveness of sensory function in the soles of the feet in DM patients at Kedung Mundu Health Center, Semarang, Central Java, by Semendawai in 2013. She explained that [10] People who performed foot exercises showed improvement in sensory function with the result of $p = 0.005$, concluding that there is a difference in the effectiveness of sensory function in patients before and after physical exercise [9].

Another study was conducted by Surianti (2014) on the effect of active lower range of motion exercise on the incidence of sensory neuropathy in non-ulcer type 2 DM patients at Wajo Regency Hospital. It was found that from 40 patients consisting of 20 people in the intervention group and 20 people in the control group, there was a significant difference between the pre-test and post-test measurements in the intervention group ($p = 0.001$). Accordingly, it can be concluded that active lower range of motion exercise affects the complaints of peripheral polyneuropathy in type 2 diabetes patients [10].

Based on a study conducted by Wayan Sukawana (2018) regarding foot exercise to improve sensory sensation in people with diabetes with diabetic peripheral neuropathy in 13 people with diabetes, it was found that all (100%) people with diabetes experienced sensory improvement after foot exercise every two days for six weeks, and 83.3% of them were free from DPN. The study concluded that foot exercises can increase sensory sensation in people with diabetes with DPN [11].

More importantly, a study conducted by Widyawati (2010) on 56 members of the Persadia Unit of Dr. Sutomo Hospital Surabaya regarding the active lower range of motion exercise on signs and symptoms of diabetic neuropathy in type 2 DM patients demonstrated that there was a difference in the mean score of complaints of polyneuropathy $p = 0.031$ in the intervention group [12].

In addition, a study by Isni Hijriana (2016) on ≥ 30 people regarding lower extremity joint movement exercise on the ankle-brachial index value in type 2 DM patients showed. There were differences in ABI values before and after lower extremity joint movement exercises. The measurement result of the ABI value before the intervention period in the left extremity was 0.90, and in the right extremity was 0.89. After the intervention, there was an increase in the ABI value in both extremities, with an average ABI value of 0.99 in the left extremity and 0.98 in the right extremity, with a value of $p = 0.00$ [13].

Similar results were also obtained by a study conducted by Ika Putri Wiji Rahayu (2017) concerning the Effect of Active Lower Range of Motion (ROM) and Heel Raise Exercise on the Value of Ankle Brachial Index in Type II Diabetes Mellitus Patients. Results indicated an effect of the active lower range of motion (ROM) and Heel Raise Exercise on the Ankle Brachial Index in Type II Diabetes Mellitus Patients with the value of $p = 0.000$ [14].

Range of motion (ROM) exercise is included in physical exercise in people with diabetes. It improves blood circulation to make it easier for nutrients to enter the cells. Physical exercise can help increase insulin receptor sensitivity, stabilizing blood sugar levels. Nerve cell damage can be avoided, and vascular endothelial function can be improved [15].

Moreover, vascularization in people with diabetes mellitus can be improved by exercising the legs [16]. Regular physical exercise can improve blood circulation. ROM exercises can stretch the leg muscles and squeeze the veins around them. The stretch pushes blood to the heart, causing venous pressure to decrease. ROM exercise is one of the interventions that can be applied to train sensory effectiveness on the soles of the feet, especially in DM patients who are still minimally exposed to ROM exercise [17].

2. Research Methods

This study utilized a pre-experimental research method in the form of a one-group pretest-posttest design; a research design conducted a pre-test before giving treatment and a post-test after treatment to compare the effects before and after the treatment. Observation and measurement were done first. Respondents were then given treatment through the active lower range of motion exercises. After the exercises, observation and re-measurement were carried out to determine the effect of the treatment that had been carried out three times a week for one month.

Respondents in this study were all DM patients in the working area of Tamamaung Health Center, Makassar, diagnosed with neuropathy, with 15 respondents. Based on the criteria, the selected respondents were given an explanation of the objectives and benefits of the study as well as the active lower range of motion (ROM) exercises that would be carried out. They signed an informed consent and were given active lower range of motion exercises three times a week, observed after one month.

Importantly, this study used an instrument in the form of a questionnaire for patient demographic data and a tool for examining the legs (sphygmomanometer). It also used the Diabetic Neuropathy Symptom Score (DNS-Score) questionnaire to determine complaints of sensory polyneuropathy in respondents and the ABI value observation sheet to measure the ABI value before and after exercise. The researchers themselves collected data. Research ethics followed the National Health Research and Development Ethics Commission (KEPPKN) 2017, which covers (1) The principle of respect for human dignity (respect for persons). (2) The principle of beneficence and nonmaleficence (3) The principle of justice in providing intervention to respondents [18].

3. Result and Discussion

Based on the Wilcoxon Statistical Test with a significance level ($\alpha = 0.05$) on sensory function, the mean value of ROM before exercise was 4.00, indicating that peripheral polyneuropathy occurred. After ROM exercise, the mean value was 1.00, indicating a decrease in the score for diabetic neuropathy symptoms but still in the range of peripheral polyneuropathy with significant results ($\rho = 0.001$), which means the value of $\rho < 0.05$. It indicates that there was an effect of ROM exercises on sensory function in diabetes mellitus patients.

Table 1. Analysis of the Effect of ROM Exercises on Sensory Function Before and After Treatment in Diabetes Mellitus Patients at Tamamaung Health Center, Makassar

Sensory Function (DNS)	n	Median	95 % CI Mean		P Value
			Min	Max	
Before	15	4.00	3.00	4.00	0.001
After		1.00	0.00	3.00	

Based on the researchers' perspective concerning the results of this study, ROM exercises greatly affect the improvement of sensory function in Diabetes Mellitus patients. The sensory function of diabetic patients got a significant value after they did ROM exercise with $p = 0.001$. It demonstrates that there was an effect after doing the ROM exercise.

According to the theory that diabetes mellitus can affect the peripheral nerves of the spinal cord, autonomic nervous system, or central nervous system, sorbitol accumulation and other metabolic changes in the synthesis of myelin function associated with hyperglycemia can lead to changes in nervous conditions resulting in neuropathy in DM patients. Neuropathy can cause patients to lose pain, pressure, or vibration sensation. During a study conducted at Tamamaung Health Center, Makassar, before giving the treatment of ROM exercise, 15 patients experienced signs and symptoms of circulatory disorders in the legs, such as walking unsteadily, walking with the help of others, and complaining of leg pain. Thus, the researchers used a DNS questionnaire to examine sensory function in DM patients and gave an active lower range of motion (ROM) exercises three times a week for 30 days.

ROM exercise is an exercise therapy in the form of movement, which is very useful in improving sensory function in people with Diabetes Mellitus. By doing ROM exercise, there is movement of the legs, resulting in stretching of the leg muscles, which can pressure the veins around the muscles. It can push blood to the heart, and the pressure in the veins will decrease. This mechanism can improve blood circulation in the legs, repair blood circulation, repair small muscles, and prevent foot deformities. Smooth circulation can inhibit the demyelination process in nerve cells, which will damage the axons so that impulse transmission, especially protection sensation receptor cells, is adequate. After diabetes mellitus patients performed ROM exercises, their sensory function in the sole was reviewed. Patients said their pain was reduced, and some stated that they did not feel pain or had no sense of the sensation given, which could be seen with stability while walking.

The results of this study are in line with a study conducted by Surianti (2014) on "the effect of active lower range of motion exercise on the incidence of sensory neuropathy in non-ulcer type 2 DM patients," which concluded that active lower range of motion exercise affects the complaints of peripheral polyneuropathy in type 2 diabetes patients ($p = 0.001$)¹⁰. It is also supported by a study conducted by Semendawai (2013) on "the effect of foot exercise on the effectiveness of sensory function in the soles of the feet," which showed that there are differences in sensory function in the soles of the feet after physical exercise ($p = 0.005$). Both of these studies applied different types of therapy but had something in common, namely improving the circulation of the leg area⁹.

The results of this study are supported by previous studies proving the research hypothesis, which states that ROM exercise can affect sensory function in diabetes mellitus patients, as evidenced by the significant difference between pre-test and post-test. Therefore, it can be concluded that ROM exercises can improve sensory function in diabetes mellitus patients with complications of sensory neuropathy.

Table 2. Analysis of the Effect of ROM Exercises on ABI Value Before and After Treatment in Diabetes Mellitus Patients at Tamamaung Health Center, Makassar

Right ABI Value	n	Median	95% CI Mean		P Value
			Min	Max	
Before	15	0.61	0.52	0.85	0.001
After		0.76	0.65	0.98	

Left ABI Value	n	Mean	SD	ρ Value
After	0.87	0.073		

Based on the Wilcoxon statistical test on the right ABI with a significance level ($\alpha = 0.05$), the median value before exercise was 0.61, indicating moderate obstruction. After the ROM exercise, the median value of the right ABI was 0.76, which means that the ABI value increased to be a mild obstruction with a significant result ($\rho = 0.001$), which indicates that the value of $\rho < 0.05$. Meanwhile, using the Paired T-Test statistical test with a significance level ($\alpha = 0.05$), the mean value of the left ABI before ROM exercises was 0.77 with ($SD = 0.094$) indicating mild obstruction. After the ROM exercise, the mean value of the left ABI was 0.87 with ($SD = 0.073$), indicating an increase in ABI value but still in the mild obstruction range with significant results ($\rho = 0.000$), which means that a value of $\rho < 0.05$. Accordingly, it can be concluded that ROM exercises have a significant effect on ABI value in diabetes mellitus patients.

The results showed that ROM exercises greatly influenced the ABI value in diabetes mellitus patients. After doing ROM exercises, there was a significant increase in the ABI value of the right leg of diabetes mellitus patients ($\rho = 0.001$) and the ABI value of the left leg ($\rho = 0.000$). It indicates an effect of ROM exercise on ABI value in diabetes mellitus patients. Diabetes mellitus patients have the potential to suffer various complications. Complications in the legs are common, which include impaired leg blood flow. It can be detected by measuring the Ankle Brachial Index (ABI), obtained by comparing the leg systolic blood pressure with the arm systolic blood pressure with a normal value ≥ 0.90 .

During a study conducted at Tamamaung Health Center, Makassar, before giving the treatment of ROM exercise, the researchers assessed the ABI value of 15 patients. The results showed that many patients had impaired blood flow, evidenced by an ABI value ≤ 90 . This is due to atherosclerosis and lack of physical exercise in diabetes mellitus patients, causing blood flow to the legs to be less smooth.

Atherosclerosis is caused by prolonged hyperglycemia, hypertension, and smoking. This study found that most respondents (10 respondents/66.7%) did not have a history of hypertension, and almost all respondents (86.7%) did not smoke. Some respondents evidenced that a need for physical exercise (10 respondents/66.7%) did not work, and all respondents (100%) had never done ROM exercises before.

Lower range of motion (ROM) exercise is an exercise that is performed to mobilize joints through a full range of motion and becomes a nursing intervention for various nursing problems with physical mobility disorders. ROM exercises can function to maintain muscle flexibility and strength, maintain joints, improve blood circulation, and prevent deformities. After doing ROM exercises three times a week for one month, the ABI value of diabetes mellitus patients was reviewed. The results showed that there was an increase in ABI value. There was severe obstruction, which became moderate, and moderate obstruction, which became mild. Surprisingly, there was also an ABI value of ≥ 90 .

The results of the study are in line with a study conducted by Isni Hijriana (2016) regarding lower extremity joint movement exercise on the ankle-brachial index value in type 2 DM patients, which showed that there were differences in ABI values before and after lower extremity joint movement exercises with value of $\rho = 0.00$. It is also by Ika Putri Wiji Rahayu (2017) concerning the Effect of Active Lower Range of Motion (ROM) and Heel Raise Exercise on the Value of Ankle Brachial Index in Type II Diabetes Mellitus Patients. Results indicated an effect of the active lower range of motion (ROM) and Heel Raise Exercise on the Ankle Brachial Index in Type II Diabetes Mellitus Patients with the value of $\rho = 0.000^{14}$.

The results of this study are supported by previous studies proving the research hypothesis that ROM exercises affect ABI value in diabetes mellitus patients as evidenced by the significant difference between pre-test and post-test. Therefore, it can be concluded that ROM exercises can improve ABI value in diabetes mellitus patients.

4. Conclusions

Based on the results of a study conducted on the effect of range of motion on sensory function and ankle-brachial index in diabetes mellitus patients at Tamamaung Health Center Makassar, it can be concluded as follows: sensory function before and after ROM exercises in diabetes mellitus patients at Tamamaung Health Center obtained a value of $\rho = 0.001$, concluding that there is an effect of ROM exercises on sensory function in diabetes mellitus patients. ABI value of Diabetes Mellitus Patients before and after ROM exercises at Tamamaung Health Center, Makassar, obtained a value of $\rho = 0,000$. On the left ABI, the value of $\rho = 0.000$, concluding that ROM exercises affect ABI value in diabetes mellitus patients.

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