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The Effectiveness of Progressive Muscle Relaxation and Neuromuscular Taping on Ankle Brachial Index Values and Quality of Life in People With Type 2 Diabetes Mellitus

Novita Fajriyah[1] and Shinta Trisnawuri[2]

[1] STIKes Adi Husada, Surabaya, Indonesia

[2] Rumah Sakit Adi Husada kapasari, Surabaya, Indonesia

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CORRESPONDING AUTHOR
Novia Fajriyah
novitafajriyah22@gmail.com
STIKes Adi Husada, Surabaya, Indonesia

ABSTRACT

Introduction: Diabetes is a chronic disease characterized by abnormal blood sugar levels due to pancreatic disorders. Quality of life and ankle brachial index values are an area of concern for nurses related to non-pharmacological treatments to prevent complications. Progressive Muscle Relaxation (PMR) can improve relaxation and cellular immunity, as well as Neuromuscular Taping (NMT) is a non-pharmacological intervention to prevent lower extremity peripheral blood circulation decline, so both have a potential positive impact on the patient's quality of life. The aim of this study is to analyze the effectiveness of PMR and NMT on ankle brachial index (ABI) and quality of life in Type 2 Diabetes Mellitus (T2DM).

Methods: The study was a quasy-experiment with a pre post test control group design. Consecutive sampling was implemented and resulted a sample of 32 T2DM patients with certain criteria, such as patients who were treated in the internal medicine ward, age 40-70 years, suffering from T2DM for more than 5 years, not suffering from diabetic ulcers, and still can do some exercise. Data were analyzed using the Wilcoxon Signed Ranks Test with correlation test with alpha 0.05.

Results: There was a significant effect of the PMR-NMT combination intervention on ABI (p= 0.034) and quality of life (p= 0.007) in the intervention group. Conversely, the control group showed no difference in ABI (p= 0.142) and quality of life (p= 0.739) before and after the study.

Conclusion: PMR and NMT can improve ABI values and Quality of Life in patients with T2DM. This PMR-NMT combination can be an alternative non-pharmacological therapy in patients T2DM to help improve ankle brachial index and quality of life.

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1. INTRODUCTION

Along with the increasing prosperity in developing countries, there is an increase in degenerative diseases, one of which is diabetes. Diabetes is a disease caused by the body's inability to metabolize, either protein, carbohydrate, or fat. Type 2 Diabetes Mellitus (T2DM) is a metabolic disorder characterized by elevated blood glucose levels due to decreased insulin secretion by pancreatic beta cells or impaired insulin function (insulin resistance) (Galicia-Garcia et al., 2020). According to the International Diabetes Federation (IDF), it is estimated that at least 463 million people between the ages of 20 and 79 worldwide will have diabetes in 2019, equivalent to the prevalence of diabetes, which is 9.3% of the total population of the same age. The prevalence of diabetes is expected to increase as the population ages to 19.9% or 111.2 million people aged 65-79 years. The number is predicted to increase to 578 million by 2030 and 700 million by 2045. Southeast Asia, where Indonesia is located,

ranks 3rd with a prevalence of 11.3%. IDF also projected the number of people with diabetes in the population aged 20-79 years in several countries in the world, which has identified 10 countries with the highest number of sufferers (Saeedi et al., 2019). Indonesia is ranked 7th among the 10 countries with the highest number of patients, at 10.7 million. Indonesia is the only Southeast Asian country on the list, so it can be estimated how much Indonesia contributes to the prevalence of diabetes cases in Southeast Asia (Infodatin 2020 Diabetes Melitus, n.d.). The prevalence of Ankle Brachial Index (ABI) with low category in DM reached 4.47% in men and 4.67% in women. ABI with a high category reached 14% in men and 10.45% in women (Putu et al., 2019).

Chronic hyperglycemia and other metabolic disorders in diabetes lead to tissue and organ damage, such as the vascular system. Blood vessels with thick plaques easily accumulate calcium causing atherosclerosis (Abouhamda et al., 2019). Atherosclerosis can lead to peripheral arterial disease (Giri et al., 2018). One of the complications of T2DM that affects the peripheral nervous system is Peripheral Arthery Disease (PAD), a condition where there are lesions in the blood vessels that cause blood flow in the arteries that supply blood to the extremities to be limited and this disease is also very feared because it affects the quality of life and social function of the sufferer (Soyoye et al., 2021).

Lower limb artery disease (LEAD) is a major endemic disease with an alarmingly increasing prevalence worldwide. It is a common and serious condition with a high risk of serious cardiovascular events and death. It also leads to high rates of lower limb adverse events and non-traumatic amputations. The American Diabetes Association recommends a thorough medical history and physical examination to screen for LEAD. Ankle brachial index (ABI) was the first non-invasive tool recommended for the diagnosis of LEAD, although its performance varies in diabetic patients (Rehab, 2019). ABI performance is mainly affected by the presence of peripheral neuropathy, medial arterial calcification and arterial incompression (Nativel et al., 2018). More than half of non-traumatic lower limb amputations are associated with diabetic complications such as autonomic and sensory neuropathy and peripheral vascular disease that can affect quality of life. PAD is associated with reduced physical ability and functional decline. This condition may lead to reduced quality of life (HRQOL) compared to cardiovascular disease due to pain, sleep disturbance and reduced physical mobility. A PAD diagnostic test with greater ABI accuracy is likely to reflect changes in one's quality of life (HRQOL) related to the condition (Reina-Bueno et al., 2021). Peripheral vascular disease can be prevented early with noninvasive vascular diagnostic methods, specifically the ankle-brachial index test (Mohammedi et al., 2016).

Several efforts can be made to prevent diabetes complications. Efforts that can be made include education related to diet and eating habits, pharmacology or treatment according to doctor's recommendations, blood sugar control, and exercise (American Diabetes Association, 2022). A physical work out that can be connected day by day and is simple to perform is dynamic muscle extending (PMR). Incremental muscle unwinding is an work out that takes put in two stages, the primary stage is to apply pressure to the muscle gather, the moment stage is to halt the extending whereas the understanding centers on how the muscles are relaxing (Toussaint et al., 2021). Additional (complementary) therapeutic management should be performed to prevent diabetic foot damage due to changes in peripheral blood flow. The results of previous studies show that neuromuscular bandaging (NMT) is a non-drug intervention used to prevent decreased peripheral blood flow to the lower extremities (Kristianto et al., 2021). NMT is used to improve blood circulation, reduce edema in the lower extremities, stimulate muscles and skin, relieve pain, and possibly relieve symptoms that occur due to disorders of the vascular nervous system (Susanti & Arofiati, 2022).

Various studies based on relaxation therapy have been conducted to overcome stress and anxiety and blood sugar, but research on the combined effects of progressive muscle relaxation (PMR) with Neuromuscular Taping (NMT) on ankle and brachial index (ABI) values and quality of life in patients with type 2 diabetes remains unexplained. Thus, the purpose of this study is to identify the effect of Progressive Muscle Relaxation (PMR) with Neuromuscular Taping (NMT) on Ankle Brachial Index (ABI) and quality of life in patients with type 2 diabetes.

2. METHODS

Study Design

This study was a quasy experiment with a pre post test control group design. In this study there were two groups of respondents, namely the control and intervention groups. The control group was not given the combination of Progressive Muscle Relaxation (PMR) and Neuromuscular Taping (NMT) and vice versa for the intervention group. Therefore, the independent variable in the study was the intervention of PMR-NMT combination, while the dependent variable were ABI and quality of life.

Population, Samples, and Sampling

The population in this study were all T2DM patients in the internal medicine ward of Adi Husada Kapasari Hospital, Surabaya, Indonesia. Thirty two T2DM patients were involved as respondents through consecutive sampling technique, and divided into two groups, which 16 respondents were in intervention group and 16 respondents were in control group.

Inclusion criteria in this study are inpatients suffering from type 2 diabetes mellitus, patients who can communicate well, patients aged 40-70 years, suffering from DM for more than 5 years, patients who do not have diabetic ulcers, patients who can still do exercise, and patients who are willing to become respondents. The exclusion criteria in this study were having severe complications such as having a history of unstable heart (angina, congestive heart failure, myocarditis, severe aortic stenosis, and arrhythmias that still require medical treatment), having diabetic feet symptoms or diabetic foot ulcer, and allergies with any kind of tapes.

Instruments

Standard Operating Procedures are used as instruments for the Progressive Muscle Relaxation (PMR) interventions, while the installation of neuromuscular taping (NMT) uses tape with fans type as well as a standard operating procedures. For ABI, author measure the ratio of the highest systolic blood pressure of the ankle (ankle) dorsalis pedis and tibialis posterior and arm (brachial) using an aneroid sphygmomanometer on each leg side and hand, so that the right and left ABI score are obtained. Interpretation of ABI values: 1) 0.90-1.30 = Normal, 0.60 - 0.89 = mild arterial obstruction, 0.40 - 0.59 = moderate obstruction, < 0.40 = severe obstruction.

Quality of life is an individual's perception of the individual's position in life related to physical, psychological and social, measured using a questionnaire. In this study, the quality of life was measured with the Diabetes Quality of Life (DQoL) questionnaire which was a revised version DQOL 13 (RV-QoL 13) that have been translated into Malaysian in a previous study and tested for validity and reliability. The development of this new instrument maintains the conceptualization of "satisfaction," "impact," and "worry" with 13 items. Validity testing was conducted based on exploratory factor analysis, confirmatory factor analysis, and Rasch analysis

Procedure

After the researchers obtained permision letter from the Stikes Adi Husada Nursing Diploma Study Program and Adi Husada Kapasari Hospital, author determining respondents based on inclusion and exclusion criteria. Before collect the data, the researcher obtained informed consent from respondent through a brief explanation about the purpose of the study, the benefits, and the procedure.

Initial observations was started before the intervention of PMR-NMT, including a measurement of ABI and QoL in both groups. Then the intervention group was given Progressive Muscle Relaxation (PMR) and Neuromuscular Taping (NMT) therapy based on Standard Operational Procedure (SOP). The NMT intervention was given for one week per respondent, while the PMR was given for 3 consecutive days in a week. On the third day of the NMT plaster installation, the plaster was removed and then replaced with a new plaster. After Progressive Muscle Relaxation (PMR) intervention for 3 consecutive days and Neuromuscular Taping (NMT) intervention for one week for each patient, a post test was conducted to measure the Ankle Brachial Index (ABI) and Quality of Life (QoL).

Data Analysis

Wilcoxon test with α= 0.05 was used to analyze the effect of combined intervention of Progressive Muscle Relaxation (PMR) and Neuromuscular Taping (NMT) on ankle brachial index (ABI) and quality of life.

Ethical Clearence

This research has been declared ethically feasible by research ethics board of STIKES Adi Husada Surabaya with a certificate number 778/PPM/SPPT/STIKES-AH/XII/2022

3. RESULTS

Table 1. The characteristics of the respondents

Variables	Intervention Group		Control Group	
	n	%	n	%
Age				
45-59 years	8	50	8	50
>60 years	8	50	8	50
Gender				
Man	8	50	3	18,7
Woman	8	50	13	81,2
Ilness duration				
5-10 Years	12	75%	14	87,5
>10 Years	4	25%	2	12,5

Table 2. Frequency distribution of ABI (Ankle Brachial Index) among T2DM patients (pre-post)

Category of ABI	Intervention group		Control group	
	pre	post	pre	post
	n (%)	n (%)	n (%)	n (%)
Normal	5 (31,3%)	11 (68,8%)	8 (50%)	9 (56,3%)
Mild arterial obstruction	11 (68,8%)	5 (31,3%)	8 (50%)	7 (43,8%)
Moderate obstruction	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Severe obstruction	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	16 (100%)	16 (100%)	16 (100%)	16 (100%)

Table 3. Frequency distribution of quality of life among patients with T2DM (pre-post)

Category of QoL	Intervention group		Control group	
	pre	post	pre	post
	n (%)	n (%)	n (%)	n (%)
Good	6 (37,5%)	12 (75%)	6 (37,5%)	5 (31,3%)
Poor	10 (62,5%)	4 (25%)	10 (62,5%)	11 (68,8%)
Total	16 (100%)	16 (100%)	16 (100%)	16 (100%)

Table 4. Statistical results of differences in pre-post Ankle Brachial Index (ABI) in T2DM patients

Data	n	mean	SD	min	max
Intervention group:					
pre test	16	1.68	0.48	1.00	2.00
post test	16	1.32	0.48	1.00	2.00
Wilcoxon Signed Ranks Test			p = 0.034		
Control group:					
pre test	16	0.89	0.09	0.70	1.09
post test	16	0.92	0.10	0.74	1.09
Wilcoxon Signed Ranks Test			p = 0.142		

Table 5. Statistical results of differences in pre-post Quality of Life (QoL) in T2DM patients

Data	n	mean	SD	min	max
Intervention group:					
pre test	16	1.38	0.50	1	2
post test	16	1.75	0.45	1	2
Wilcoxon Signed Ranks Test			p = 0.034		
Control group:					
pre test	16	1.38	0.50	1	2
post test	16	1.31	0.48	1	2
Wilcoxon Signed Ranks Test			p = 0.739		

Based on the results of table 1, the age of the respondents consisted of middle age (45 to 59 years) as many as 8 (50%) respondents in the intervention group and control group, while the rest (50%) were in the elderly category (> 60 years). The intervention group consisted of male and female respondents in equal proportions (50% each), while in the control group the majority (81.2%) were women. Furthermore, in the intervention group, most of the respondents (75%) had T2DM since 5-10 years ago, as well as in the control group (87.5%).

Based on table 2, it is known that before being given the PMR-NMT combination intervention, most of the respondents (68.8%) in the intervention group showed an ankle brachial index in the category of mild arterial obstruction, while those in the control group showed the same proportion at a normal category of ABI (50%) and mild arterial obstruction category (50%). Post-intervention, respondents in the intervention group showed the development of the normal ABI category which increased to 68.8%, as well as in the control group (increased to 56.3%), although it was only a slight increase.

Table 3 shows that most of the respondents in the intervention group (62.5%), as well as the control group (62.5%) had a poor QoL. Post-intervention, most of the respondents in the intervention group showed progress and reached a good QoL up to 75%, while most of the respondents in the control group had a poor QoL (68.8%).

Table 4 shows the results of the Wilcoxon signed rank test for both groups of respondents. In the intervention group, there was a significant difference in ABI before and after the PMR-NMT combination intervention, as indicated by a p-value of 0.034 (<0.05). On the other hand, the results of the Wilcoxon test in the control group showed no significant difference for the ABI pre test and post test which indicated a p value of 0.142 (> 0.05).

Table 5 shows the results of the Wilcoxon Signed Ranks Test showed a significant difference in the quality of life (QoL) of T2DM patients in the intervention group before and after the implementation of the PMR-NMT combination, which indicated a p value of 0.034 (<0.05). In contrast, the results of the Wilcoxon Signed Ranks Test in the control group showed no significant difference in the QoL pre and post tests, which indicated a p value of 0.739 (>0.05).

4. DISCUSSION

Analysis of Ankle Brachial Index in T2DM patients before and after a combination of Progressive Muscle Relaxation and Neuromuscular Taping

From table 4 it is known that there is an effect of the combined intervention of Progressive Muscle Relaxation and Neuromuscular Tapping (PMR-NMT) on the quality of life of T2DM patients. In contrast, statistical analysis of the pre-test and post-test in the control group using the Wilcoxon Signed Ranks Test showed that there was no significant difference in the quality of life of T2DM patients between the pre- and post-test.

The results of this study are supported by previous researchers that there is an effect on changes in Ankle Brachial Index (ABI) values before and after Neuromuscular Taping (NMT) interventions and diabetic foot exercises. There is a significant difference between the intervention group and the control group on changes in Ankle Brachial Index (ABI) values (Susanti & Arofiati, 2022). ABI examination is carried out to determine the strength of peripheral vascular circulation towards the legs in diabetics. In patients who experience leg blood circulation disorders, it will be

found that leg blood pressure is lower than arm blood pressure Poor peripheral circulation of the leg area is one of the factors triggering the occurrence of foot ulcers in diabetics, in addition to neuropathy and infection factors. (Ahmad & Mittal, 2015; Nilay D. Solanki, Shailesh K Bhavsar, 2018). The combination of progressive muscle relaxation and neuromuscular taping allows the body to relax and improves blood circulation. Smooth blood circulation after a move can stimulate the blood to deliver more oxygen and nutrients to the body's cells, as well as help carry more toxins for elimination. Physical activity and stretching during PMR movements lead to increased blood pressure in the blood vessels (Aneesa & Preetha, 2016; Varacallo, 2018). Continuous inhibition stimulates vasodilation by increasing nitric oxide synthase or (NOS) expression and releasing NO. Nitic oxide (NO) is a small reactive molecule known as a biomessenger. NO in blood vessels causes smooth muscle relaxation which serves as a regulator of blood flow and pressure and prevents platelet aggregation and adhesion. NO also aids oxygen transportation by dilating the blood vessel wall, facilitating gas transfer to tissues and vice versa (He et al., 2022). Research also conducted by Simanjuntak 2017 states that increased blood sugar levels can affect blood viscosity and become platelet aggregation, which will stimulate the formation of microthrombi, and microvascular blockage, this will worsen the value of the ankle index. Exercise is one of the principles of diabetes treatment. Gradual muscle relaxation is a non-pharmacological approach to diabetes control to treat tingling symptoms caused by poor foot blood flow and can improve foot blood flow. Combination of PMR and Neurotaping can improve ABI values (Juster-Switlyk & Smith, 2016; Williams et al., 2018).

PMR and Neuromuscular taping performances can increase the patient's sense of relaxation, stimulating the production of endocrine hormones. When the patient is relaxed, brain activity and other body functions decrease due to reduced oxygen consumption. As for the body's metabolic activity is also reduced, with a decrease in metabolic activity, it is thought that blood sugar levels in the body will be more stable (Kahn et al., 2014; Smith et al., 2018). Stable blood sugar can prevent peripheral circulatory disorders, which can be determined by measuring the index finger and ankle. This is because progressive muscle relaxation and neuromuscular bandaging can improve blood circulation in the feet (Evans et al., 2019; Jin et al., 2015). Progressive muscle relaxation and other predisposing factors, ABI values can be controlled to normal so that it can be used as an alternative in the prevention of peripheral arterial disease, table ulcers, diabetic foot and other complications (Kumar S, Nayak RR, 2015; Lazarou et al., 2017).

Analysis of Quality of Life in T2DM patients before and after a combination of Progressive Muscle Relaxation and Neuromuscular Taping in the intervention group.

Table 5 shows a statistical analysis of the Wilcoxon Signed Ranks Test on the pre-test and post-test quality of life of T2DM patients in the intervention group which showed the effect of a combination of Progressive Muscle Relaxation (PMR) and Neuromuscular Tapping (NMT) actions on quality of life. In contrast, the results of the Wilcoxon Signed Ranks Test in the control group showed no significant difference in the pre and post test quality of life of T2DM patients.

This is in accordance with research which states that there is an effect of giving progessive muscle relaxation on improving quality of life in T2DM patients (Rokhman & Supriati, 2018). Quality of life is needed for individuals suffering from diabetes mellitus in the treatment process, so that individuals pay more attention to how to improve their quality of life to be able to achieve a better physical condition and reduce the severity of the disease they suffer (Lin et al., 2017; Spasić et al., 2014; Trikkalinou et al., 2017).

Complications are a contributing factor to the low quality of life of DM patients, complications cause increased patient complaints, both physical and psychological and emotional but also affect physical, social. and other complaints, almost all patients have different complaints depending on comorbidities, most complain of pain in the feet and other extremities that affect the quality of physical activity, the sensation of pain in the feet causes discomfort and affects the patient's quality of life (Schweyer, 2015).

A directed exercise that involves systematic contraction and relaxation of muscle groups, starting with the facial muscles and ending with the leg muscles. The benefits of progressive muscle relaxation are a reduction in the body's oxygen consumption, metabolic rate, respiratory rate, muscle tension, premature ventricular contraction, and systolic blood pressure as well as alpha and Can increase beta endorphins and function to increase cellular immunity. Relaxation can be used as a positive coping skill when used to treat anxiety so that one's quality of life is improved. (Bujang et al., 2018; Toussaint et al., 2021).

Neuromuscular Taping is the decompressive application of elastic tape to the skin in the diabetic foot which has the effect of reducing the inflammatory response, improving vascularization and neuromusculoskeletal function. It aims to improve the function of the neuromusculoskeletal and lymphatic systems due to the presence of wrinkles, which indicate dilation, with local effects on sensorimotor and proprioceptive senses in treatment, rehabilitation, and injury conditions (Kristianto et al., 2021). Providing Neuromuscular Taping (NMT) intervention of the lymphatic system with decompression technique is done by placing a bandage for one week and changing the bandage every three days. The decompression technique can

create folds in the bandage that cause the diaper to stretch. The skin tightening that occurs causes the pressure on the skin tissue to decrease and the circulation under the ice becomes smooth and increases the ABI value (Susanti & Arofiati, 2022). Thus, the researchers were able to conclude that the combination of progressive muscle relaxation and neuromuscular taping can improve quality of life where quality of life was initially reduced. In the control group, respondents could improve their quality of life by doing good things and acting with a calm and focused mind.

LIMITATION

The limitation of this study is that it did not carry out a direct comparation test such as the Mann Whitney U test to compare ABI and QoL data between the two groups (intervention and control), so that interpretation is only based on the difference test on paired data (pre and post) in each group of respondents.

CONCLUSION

Progressive Muscle Relaxation and Neuromuscular Taping Combination Therapy can improve ABI (Ankle Brachial Index) values and Quality of Life in patients with type 2 diabetes mellitus. This combination of therapies can be an alternative non-pharmacological therapy in patients with type 2 diabetes mellitus to help improve ABI (Ankle Brachial Index) and quality of life.

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