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A review of the effect of therapeutic exercise on polyneuropathy in patients with diabetes

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Abstract

The negative effect of diabetes on the microcirculation of the lower limbs and the lesions it causes in the peripheral nervous system have been documented. Diabetic peripheral neuropathy (DPN) causes damage to the peripheral nerves of the limbs leading to paresthesia and other side effects. Exercise seems to have a positive effect on improving the symptoms of peripheral neuropathy. The aim of this literature review was to investigate the benefits of exercise in the context of physiotherapy intervention in patients with DPN. A literature search was performed in the databases PubMed and Cochrane Central Register of Controlled Trials in English with the following keywords: diabetes, peripheral neuropathy, physiotherapy interventions, therapeutic exercises. Clinical trials as well as systematic reviews were included in this review with a total of nine articles. Our results reinforce the notion that exercise has a positive effect in reducing sensory disorders and better managing the symptoms of diabetic patients with peripheral polyneuropathy. Physiotherapy interventions should integrate therapeutic exercise into treatment programs in order to achieve optimal results.

Keywords: Diabetes, peripheral neuropathy, physiotherapy interventions, therapeutic exercises

Introduction

According to recent research, approximately 350 million people worldwide are affected by diabetes [1]. The vast majority of cases concern Type 2 diabetes, which is characterized by high blood glucose levels in the context of insulin resistance and relative insulin deficiency due to metabolic disorders [2]. High blood glucose levels damage both the vascular and peripheral nervous systems [3]. Diabetic peripheral neuropathy (DPN), which is divided into polyneuropathy and mononeuropathy, is a common clinical manifestation of the peripheral nervous system in patients with diabetes [4]. The link between insulin resistance and microvascular complications, such as neuropathy and endothelial dysfunction, has been established by several researchers [5]. Most often polyneuropathy is likely to be secondary, caused by various factors such as poor blood sugar control and elevated glucose levels over a long period of time [6]. Symptoms are more common in the lower limbs and include paresthesia, hyperalgesia or gradual loss of sensation in the extremities of the legs on both sides [7]. In advanced stages, sensory disorders can create fertile ground for leg ulcers, increasing the risk of amputation [8].

The incidence of peripheral polyneuropathy in patients with diabetes is very high, reaching 54% of all cases in Type 1 diabetes and 45% in other types of diabetes [9]. Risk factors for developing DPN include age, obesity, smoking, low glycemic control and hypertension [10]. Studies have shown that the incidence of peripheral polyneuropathy increases with age, with people over the age of 50 accounting for 32% of all cases [6, 11].

The etiology of diabetic polyneuropathy is not fully understood [12]. The most common causalities are a sedentary lifestyle, low levels of physical activity and obesity [13]. For this reason, exercise provides benefits to patients with diabetic polyneuropathy [14]. Research has shown that exercising for 8-12 weeks brings significant improvements in sensory disorders without increasing the risk of injury [12, 14]. However, the intensity, frequency and type of training are factors that need further study. The aim of this review was to investigate the efficacy of therapeutic exercise in patients with peripheral diabetic polyneuropathy.

Method

The PubMed and Cochrane databases were searched between 1/4/2021 and 9/5/2021. The search was done in English with the following keywords: diabetes, peripheral neuropathy, physiotherapy, therapeutic exercises. Inclusion criteria for the articles were to be clinical studies or systematic reviews that have been applied to samples of patients with polyneuropathy due to diabetes and to have studied the effect of therapeutic exercise (alone or in combination with other therapy methods). The initial result from the search was 155 articles of which 59 were not related to physiotherapy, so they were excluded. After the removing the duplicates, 16 articles remained of which seven did not meet the inclusion criteria. Eventually, nine articles were included in the review. Below are the main findings of these studies.

Results

In the pilot study of Kluding et al. [15], the effect of exercise on DPN was studied in 18 adult participants, who followed a 16-week aerobic exercise program administered by a group of physiotherapists. The results of the study showed improvements in fatigue, maximal oxygen uptake ($\dot{V}O_2\text{max}$), total body fat, body mass index (BMI) and peripheral blood flow. This study provided data on the benefits of aerobic exercise in people with diabetic polyneuropathy. However, the researchers noted that it is important for physiotherapists to be careful about the initial intensity of exercise, especially in the early stages of the intervention, to avoid side effects in patients.

Goldsmith et al. [16] conducted a randomized controlled trial in 19 patients with diabetes to determine the effects of therapeutic exercise on joint mobility and plantar pressure. The participants were divided into an intervention and control group. The nine individuals of the intervention group performed active and passive range of motion exercises of the lower limb joints, while the rest did not follow any treatment. The range of motion of the lower limb joints and the peak plantar pressure were assessed at the beginning and end of the intervention. After one month of treatment, a statistically significant decrease ($p < .05$) in peak plantar pressure was observed in both groups compared to baseline values, with the exercise group exhibiting slightly better values than the control group. Although no statistically significant differences were found between the groups, a tendency for reduced joint stiffness was noted. The results of this study show that since high plantar pressures have been associated with diabetic neuropathic ulcers, it is possible that physiotherapy in the form of range of motion exercises can help to reduce the risk of such ulcers.

The study of Billinger et al. [17] examined whether a 16-week aerobic exercise intervention can improve blood flow in patients with DPN. 17 participants were divided into two groups (intervention and control). The Doppler ultrasound was used to assess brachial artery diameter and peak shear stress and it was evaluated before and after the intervention. The results showed a statistically significant increase in artery diameter in the exercise group after the intervention. It was also found that a longer duration (in years) of peripheral neuropathy showed a negative correlation with the percentage change in maximal vascular blood flow. The researchers concluded that aerobic exercise was beneficial for improving vascular health.

Furthermore, in the study of Yoo et al. [18] the effect of aerobic exercise on the improvement of neuropathic pain in patients with peripheral neuropathy was evaluated. The study

involved 14 sedentary individuals with severe DPN, who enrolled in a supervised 16-week aerobic exercise program. Pain was evaluated with the Brief Pain Inventory questionnaire for DPN before and after the intervention. Significant reductions in pain were observed in the intervention group in activities such as walking, work, sleep and general daily life activities. According to the researchers, these results suggest that aerobic exercise can effectively reduce pain in diabetics with peripheral polyneuropathy.

In another 12-month randomized controlled trial applied to 79 people with DPN [19], it was found that weight-bearing activity not only did not lead to significant increases in leg ulcers, but also helped to maintain the good health of the participants. The participants were randomly assigned either to a control group ($n=38$) or an intervention group ($n=41$). The intervention group followed a program with resistance and balance exercises for the lower limbs. The researchers concluded that weight-bearing activities may not be a contraindication for people with DPN.

The study of Richardson et al. [20] involved 20 participants with DPN, who were divided into two groups (intervention and control). The participants of the intervention group followed a program of resistance and balance exercises for three weeks. The unipedal stance time, functional reach, tandem stance time and score on the Activities-specific Balance and Confidence (ABC) scale were evaluated before and after the intervention. The results showed a significant improvement in all the examined variables and led to the conclusion that a short, specific exercise regimen improved balance in patients with DPN.

More targeted exercise programs have also been used by physiotherapists to aid in peripheral neuropathy problems by improving microcirculation. The study of Wang et al. [21] evaluated the Tai Chi Chuan (TCC) training in geriatric patients with sedentary lifestyle and peripheral neuropathy. The TCC group had 34% higher $\dot{V}O_2\text{peak}$ than the control group and higher cutaneous vascular conductance and skin temperature than the control group at rest and during exercise. These data suggest a possible positive relationship between improved microcirculation and peripheral neuropathy.

In another study by Grewal et al. [22], 39 people with DPN, who followed physiotherapy intervention with interactive exercise in a virtual environment, adapted to people with diabetes (twice a week for four weeks) were studied. The exercises focused on weight shifting and overcoming virtual obstacles. The sensors were applied to the body to obtain kinematic data and provide real-time visual feedback during training. The results of this randomized controlled trial show that people with DPN can significantly improve their static balance and the symptoms of peripheral neuropathy with specialized exercise.

Lastly, in the review of Cai et al. [23], 30 studies with 2785 participants with peripheral neuropathy in Type 2 diabetes were included. Exercise-based physiotherapy intervention was divided into four types of exercise: aerobics, resistance training, a combination of aerobics and resistance and yoga. Aerobic exercise showed a significant positive effect between the groups. Resistance training and combined exercise showed mixed results. Yoga also exhibited good effects on quality of life. According to the researchers, the effect of aerobic exercise on quality of life in people with Type 2 diabetes was safe and positive. The effects of resistance exercise and combined exercise on quality of life in people with Type 2 diabetes were mixed, while the effect of yoga needs further study.

Discussion

In this literature review, DPN and targeted intervention based on exercise to combat it were studied. The results of our review showed that aerobic exercise is the first choice of therapeutic exercise in clinical practice in patients with DPN. Additionally, other interventions such as balance exercises also seem to help these patients significantly, but to a lesser extent [20]. The results of this review confirm the results of other studies regarding the positive effect of exercise on diabetics with polyneuropathy [23, 24]. Targeted exercise and training programs have shown significant effects on neuropathy outcomes and a positive effect on slowing the onset or progression of leg ulcers [16]. Physiotherapists are recommended to start training with light exercises based on the progression of the disease. The most important areas that improve during physiotherapy intervention with exercise regarding the patients are their physical condition, endurance, level of disability and compliance with the exercise program. Improvement of leg and ankle functioning, range of motion, gait speed, daily level of physical activity, lifestyle patterns, muscle strength or balance, as well as neuropathic symptoms were all reported as positive parameters in the evaluation of the intervention.

Conclusions

Therapeutic exercise should be an integral part of physiotherapy intervention in patients with DPN. Aerobic exercise seems to provide the greatest benefits of all the training types. However, more research is needed to understand the exact effects of exercise on this specific patient category.

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