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ORIGINAL ARTICLE

Effect of aerobic training on nerve conduction in men with type 2 diabetes and peripheral neuropathy: A randomized controlled trial

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KEYWORDS
Diabetic neuropathy;
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Summary
Objective. — Peripheral neuropathy (PN) is one of the long-term complications of diabetes. Few studies have investigated the role of regular exercise on diabetic PN. We examined the effect of aerobic training on nerve conduction velocity and action potential amplitude in the lower limbs of men with type 2 diabetes and PN.
Methods. — In a randomized controlled study, 24 volunteers diagnosed with diabetic PN were randomly assigned to exercise or control groups. Aerobic training consisted of 20—45 min walking or running at 50—70% of heart rate reserve for three sessions per week over 12 weeks. Before and 48 h after the experimental period, nerve conduction studies were performed and blood samples were taken to be analyzed for HbA1c, fasting and 2 h postprandial glucose concentration. Data were analyzed using repeated-measures ANOVA at significance level of $P < 0.05$.

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Results. — Sural sensory nerve conduction velocity (NCV) in the exercise group significantly increased (from 35.2 ± 4.3 m/s to 37.3 ± 6.2 m/s) compared to the control group ($P = 0.007$). Changes in peroneal and tibial motor NCV and nerve action potential amplitude (NAPA) in all nerves studied were not different between groups ($P > 0.05$). Moreover, HbA1c decreased to a greater extent in the exercise group compared to the control ($P = 0.014$).
Conclusion. — Aerobic exercise training may have the potential to hinder the progression of diabetic PN by improving NCV. Given the sparse evidence in this domain, exercise-related mechanisms need to be studied in the future.

Introduction

Peripheral neuropathy (PN) is one of the long-term complications of diabetes. The most common form of PN is symmetrical neuropathy, characterized by peripheral sensory and motor nerves dysfunction in a length-dependent manner [6,25]. It exhibits a ''stocking and glove'' distribution and is sensory predominant, the lower extremity sensory nerves being affected earlier. In the course of the disease, some patients experience painful neuropathy (e.g. burning, prickling, stabbing) while others may have no signs and symptoms of disease [6]. Symptoms alone are thus a poor predictor of disease, and nerve conduction abnormalities are more reliable to predict PN [23]. It has been suggested that nerve conduction measurement is a reliable and well-adapted measure to monitor diabetic PN [11,23]. Hence, electrodiagnostic studies are recommended to monitor disease in clinical research. It is believed that metabolic and vascular factors are involved in the pathogenesis of PN [7,28]. To date, no decisive treatment has been described for PN and most treatments focus on pain relief strategies. However, numerous studies have shown that PN can be significantly reduced by optimal glycemic control [4].

Previous research has described that lifestyle modifications, including regular exercise and standard diet, can reduce the prevalence of diabetes and associated complications [3,9,27]. Regular exercise leads to improvements in body composition, insulin sensitivity, glucose concentrations, lipid profile and vascular function [24]. Despite extensive literature on the benefits of exercise on diabetes, very few studies have focused on the effect of exercise on diabetic PN, perhaps due to investigators' concern with respect to possible weight-bearing exercise-related injuries in this group of patients. However, it has been recently reported that patients with PN can safely engage in moderately intense aerobic and resistance exercise [20]. A cross-sectional study suggested that there is a correlation between physical activity level, HbA1c and prevalence of PN. It was reported that proper physical activity coupled with good glycemic control was associated with less neuropathy [21]. Balducci et al. conducted a study on diabetic patients without neuropathy and reported that long-term aerobic training can prevent or delay the onset of PN in diabetic patients without PN [2]. More recently, the Look AHEAD Research Group reported that long-term lifestyle modification program significantly decreased DPN, as assessed using a questionnaire-based approach [15]. From these few studies, the effectiveness of exercise program on electrodiagnostic measures of DPN cannot be concluded.

Since metabolic and vascular factors are underlying causes of diabetic PN [7,28], and on the other hand, exercise results in favorable metabolic and vascular changes [26], we hypothesized that a supervised aerobic exercise program would improve nerve function in patients with established PN. In the present study, nerve conduction velocity and action potential amplitude of sensory sural and motor peroneal and tibial nerves were examined before and after twelve weeks of aerobic exercise training.

Methods

Participants

Volunteers were recruited from diabetes clinics, and diabetes center of Shahid Mahallati hospital (Tabriz, Iran). The medical records of patients were reviewed for eligibility and patients with type 2 diabetes and peripheral neuropathy were invited for additional evaluations. Inclusion criteria included diabetes history of more than 5 years, HbA1c between 6.6% and 12%, and diagnosed diabetic peripheral neuropathy. The presence of diabetic PN was confirmed by an endocrinologist and a neurologist using previously described standard criteria and the ''confirmed'' clinical level was considered for diabetic PN diagnosis [10]. Since a large number of patients was screened at the first step (Fig. 1), the Michigan Neuropathy Screening Instrument (MNSI) was applied for initial screening and patients scoring ≥ 3 were considered eligible for additional evaluations [13]. Patients were then assessed using the Michigan diabetic Neuropathy Score (MDNS) and patients with moderate neuropathy were included. Finally, to confirm the presence of PN, nerve conduction studies was performed according to the standard criteria [8,10]. The enrolled participants in the present study were physically inactive. According to the Rapid Assessment of Physical Activity (RAPA) questionnaire, participants were defined to be inactive [29] (the inclusion and exclusion criteria are detailed in Fig. 1). Thirty-one patients with type 2 diabetes met the inclusion criteria. However, throughout the study course, 7 participants (4

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