

## Effect of Cycling Exercises on Ankle-Brachial Index in Subjects with Peripheral Artery Disease: A Randomized Controlled Study

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### ABSTRACT

**Background:** Supervised exercise training is very beneficial in patients with peripheral artery disease (PAD). Cycling exercise has been found to increase peripheral blood flow in patients with PAD.

**Objective:** This study aimed to investigate the effect of cycling exercise on ankle-brachial index (ABI) in patients with PAD.

**Methods:** Fifty patients with PAD were randomized into two groups (n=25 each): An exercise group that received cycling exercises for 20–30 min/session, 3 times/week for 8 weeks, plus medications, and a control group that received medications only. The outcome measure was ABI.

**Results:** There were significant improvements in the ABI within both groups compared to baseline ( $p < 0.001$ ). Between-group analysis showed that the improvement in the ABI was significantly greater in the exercise group than in the control group ( $p < 0.001$ ).

**Conclusion:** In addition to pharmacological treatment, cycling exercises may result in greater improvement in the ABI than pharmacological treatment alone in patients with PAD.

**Keywords:** ABI, Cycling, Exercise, PAD.

### INTRODUCTION

By 2050, there will be an astounding 360 million PAD cases globally, a 220% rise <sup>[1]</sup>. Although PAD has historically been thought of as a disease that mostly affects males, current demographic trends and research indicate that women are affected at least as frequently as men. In addition to making up a growing percentage of PAD patients, women make up a higher share of the senior population than males <sup>[2]</sup>. For many PAD patients, the cornerstone of treatment is medical therapy combined with exercise and risk factor management <sup>[3]</sup>.

According to current guidelines, individuals with a history or examination results indicating PAD should undergo resting ABI testing <sup>[4]</sup>. As a first-line, non-invasive treatment for PAD, supervised exercise therapy is highly recommended by both the American Heart Association and the European Society of Cardiology <sup>[5]</sup>. When compared to other more intrusive medicines, exercise regimens offer a low-risk and reasonably priced choice <sup>[6]</sup>.

Exercise techniques such as strength training, cycling, and upper-limb ergometry have been studied <sup>[7]</sup>. Cycling exercise has been shown in earlier studies to improve ABI in PAD patients <sup>[7]</sup>. To confirm earlier results, the purpose of this study was to investigate the effect of cycling exercise on ABI in patients with PAD.

### SUBJECTS AND METHODS

**Subjects:** This is a randomized controlled study, **fifty subjects** with PAD were recruited for the study.

**Inclusion criteria:** Mild to moderate PAD, symptomatic PAD, males and females, aged 40-60 years old, and BMI from 25.0 to 29.9 kg/m<sup>2</sup>.

**Exclusion criteria:** Cardiac or pulmonary disease and severe musculoskeletal problems.

Subjects were divided randomly into **two groups**: an **Exercise group (n=25)** and a **Control group (n=25)**.

### METHODS

#### 1. Randomization

A simple randomization method was used in the present study. A randomization sequence was created by software. Concealed allocation was ensured.

#### 2. Blinding

The assessor of the outcome measure was blinded to patient allocation.

#### 3. Evaluation

**History and physical examination:** Patient history was obtained to gather information about their overall health status, level of physical activity, and current medications. Also, a physical examination was done by a physician. The body weight, height, and body mass index were measured for all patients at baseline.

**The ABI:** ABI was measured by Doppler ultrasonography at the beginning and at the end of the program of exercise as per the guidelines <sup>[8]</sup>.

#### 4. Interventions

**Pharmacological treatment:** All patients in the two groups received pharmacological treatment to improve blood flow.

**Exercise intervention:** Only patients in the exercise group received moderate cycling exercises for 20 to 30 minutes at moderate claudication pain and 65%-75% of peak heart rate. A 5-10-minute warming-up and a 3-minute cooling-down were included. Patients exercised 3 days/week for 8 weeks. A rest was allowed if claudication pain was severe during exercise.

**Ethical approval:** This study was approved by The Ethics Committee of Faculty of Physical Therapy, Cairo University. Each participant signed a consent form after all information was received. Throughout its execution, the study complied with the Helsinki Declaration.

#### Statistical analysis

The researchers checked the data, coded it, and used IBM-SPSS Statistics for Windows, version 23.0, for analysis. Descriptive statistics were expressed as mean  $\pm$  SD. The Unpaired T-test was used for testing the difference in the means between the two groups. A paired t- test was used to analyze the difference in the means within each group. The *p*-value was set at  $\leq 0.05$ .

#### RESULTS

The mean  $\pm$  SD of age in the exercise group was  $48.80 \pm 6.60$  years, and in the control group was  $48.52 \pm 6.26$  years. There were 14 male patients and 11 female patients in the exercise group; and 17 male patients and 8 female patients in the control group (Table 1).

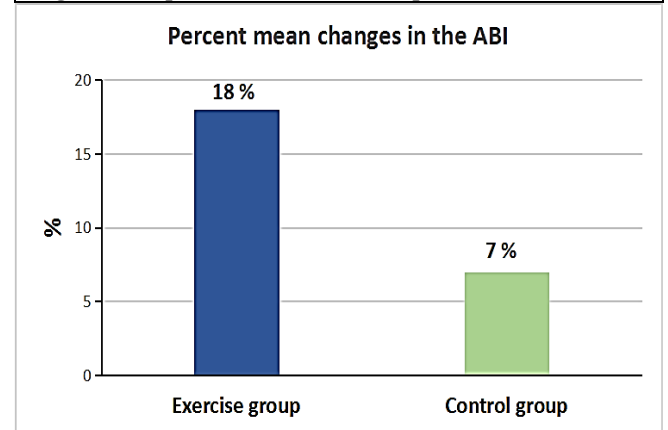
**Table (1):** Baseline characteristics in the two groups

| Characteristics                                                                       |         | Exercise group (n=25) | Control group (n=25) |
|---------------------------------------------------------------------------------------|---------|-----------------------|----------------------|
| Age (years)                                                                           |         | $48.80 \pm 6.60$      | $48.52 \pm 6.26$     |
| Gender                                                                                | Males   | 14 (56%)              | 17 (68 %)            |
|                                                                                       | Females | 11 (44%)              | 8 (32 %)             |
| BMI (kg/m <sup>2</sup> )                                                              |         | $27.25 \pm 1.36$      | $27.43 \pm 1.22$     |
| Data were means $\pm$ SD and frequency and percent distribution. BMI: Body mass index |         |                       |                      |

The mean  $\pm$  SD of the ABI in the exercise group increased significantly from  $0.73 \pm 0.11$ , to  $0.86 \pm 0.11$  ( $p < 0.001$ ). The mean  $\pm$  SD of the ABI in the control group increased significantly from  $0.69 \pm 0.09$  to  $0.74 \pm 0.09$  ( $p < 0.001$ ). The comparison between groups revealed a significant difference between them in favor of the exercise group ( $p < 0.001$ ) (Table 2). The percent mean changes from baseline in the ABI within the two groups are presented in figure (1).

**Table (2):** Results of the ABI before and after interventions

| Ankle-Brachial Index                                                                            | Exercise group (n=25) | Control group (n=25) | p-value       |
|-------------------------------------------------------------------------------------------------|-----------------------|----------------------|---------------|
| Pre                                                                                             | $0.73 \pm 0.11$       | $0.69 \pm 0.09$      | 0.165         |
| Post                                                                                            | $0.86 \pm 0.11$       | $0.74 \pm 0.09$      | $<0.001^{\#}$ |
| p-value                                                                                         | $<0.001^*$            | $<0.001^*$           |               |
| *: Significant p_value based on Paired t-test. #: Significant p_value based on Unpaired t-test. |                       |                      |               |



**Figure (1):** Percent mean changes in the ABI within the two groups.

#### DISCUSSION

The aim of this randomized controlled trial was to investigate the effect of cycling exercise on ABI in patients with PAD. The major finding in the present study was that cycling exercises combined with pharmacological treatment resulted in a more significant improvement in the ABI compared to pharmacological treatment alone in patients with PAD.

The first line of treatment for claudication has been suggested to be supervised exercise regimens [9]. Exercise training is beneficial even for patients with PAD without claudication, according to recent research [10]. The clinical course of PAD may be changed by combining exercise regimens with risk factor reduction [11]. Reducing limb symptoms, increasing exercise capacity and preventing or minimizing physical handicap and lowering the incidence of cardiovascular events are the three main objectives of comprehensive preventative techniques, which include exercise [12].

In this trial, the mean  $\pm$  SD of the ABI in the exercise group increased significantly from  $0.73 \pm 0.11$ , to  $0.86 \pm 0.11$  ( $p < 0.001$ ). The mean  $\pm$  SD of the ABI in the control group increased significantly from  $0.69 \pm 0.09$  to  $0.74 \pm 0.09$  ( $p < 0.001$ ).

Treadmill walking has long been considered the gold standard for PAD rehabilitation [13]. Cycling, however, is frequently more tolerable, especially for people who have severe claudication, joint pain, or balance problems [14]. Cycling supports an all-encompassing approach to reaching health goals because it can strengthen muscles, improve cardiovascular fitness, raise levels of consciousness and

mental well-being, encourage physical activity, lower the risk of chronic diseases, contribute to environmental sustainability, and offer an accessible form of exercise for people of all ages and fitness levels <sup>[15]</sup>.

Our trial showed that the comparison between groups revealed a significant difference between them in favor of the exercise group ( $p < 0.001$ ).

Clinical trials indicated that cycling improves ABI and muscle perfusion in patients with PAD <sup>[16]</sup>. Our findings align with **Hsu et al.** <sup>[15]</sup> who found that cycling exercises improve ABI and muscle perfusion in patients with PAD. Also, it has been shown that exercise of the lower extremities can increase the value of ABI <sup>[17, 18]</sup>. The underlying mechanism could be that exercise can promote endothelial recovery in patients with PAD <sup>[19]</sup>.

## LIMITATIONS

The relatively small sample size. Also, the effect of exercise on the ABI in male and female patients, separately, could not be identified. Strengths of this study include its design as a randomized trial. Additionally, the assessor of the outcome measure was blinded to patient allocation.

## CONCLUSION

Cycling exercises in addition to pharmacological treatment could result in more improvement in ABI than pharmacological treatment alone in patients with PAD. This discovery may strengthen the function of exercise training in the therapy of PAD. Future multi-center randomized trials with a larger sample may be needed.

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