# Benefits of 6 Months Training in Intermittent Claudication

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## ABSTRACT

***Background:*** *Intermittent Claudication is the most common and usually the presenting symptom of chronic obstructive arterial disease of lower limbs. Claudication is an important cause of impaired exercise capacity, which limits a patient s ability to walk and thus to meet the personal, social and occupational demands of daily life. In contrast to other forms of therapy for Claudication, exercise rehabilitation is a well-established, highly effective mode of intervention, which has very low morbidity and mortality attached to it. A program of supervised exercise rehabilitation has been shown to be a highly efficacious treatment for claudication. This type of treatment, in some form, has been recommended as a mean to help patients with peripheral arterial disease improve their walking ability.*

***Purpose:*** *The aim of this study was to investigate the effect of six months training on intermittent claudication.*

***Method:*** *Ten patients (mean age 55.7±7.02 year), with stable Claudication symptoms due to chronic obstructive arterial disease, underwent a training program on the treadmill for six months. A written informed consent was taken from every one of them. Pain free and maximum walking times, calf blood flow either rest flow or peak flow, and ankle systolic blood pressure were measured before starting and after completion of the program.*

***Results:*** *pain free and maximum walking times were prolonged significantly after training by 67% from 1.86±0.49 to 3.16±1.33 and 294 % from 5.72±3.76 to 22.56±17.99 respectively. Also, the ankle systolic pressure was increased significantly by 1.6% from 122.2±6.78 to 124.2±6.34, while the rest and peak calf blood flows were increased significantly by 58% from 3.04±1.27 to 4.79±2.1 and 41% from 11.45±3.21 to 16.15±6.3 respectively. These changes can be attributed to adaptations in peripheral blood flow or distribution of flow, improvement in oxygen delivery to skeletal muscle due to a decrease in blood viscosity or an increased capillary density.*

***Conclusion:*** *Because of the benefits of physical training, in addition to the low associated morbidity, it is recommended as an important treatment option for people with intermittent claudication due to chronic obstructive arterial disease.*

## INTRODUCTION

Intermittent claudication is the most common symptomatic manifestation of mild to moderate atherosclerotic peripheral arterial occlusive disease. The annual incidence of intermittent claudication is about 20 per 1000 in people over 65 years old[1-10]. Importantly, intermittent claudication may significantly curtail the functional independence of patients. A limited ability to ambulate represents a disability when people

are unable to perform their normal personal, social and occupational activities[4]. Exercise rehabilitation is an effective therapy for the clinical management of intermittent claudication in patients with peripheral arterial disease. Because ischemia within the leg musculature during exercise may trigger the adaptive improvements in claudication pain and peripheral circulation,walking to maximal ischemic leg pain may be an effective exercise strategy for claudication patients, provided that such exercise can be performed safely[16]. Exercise rehabilitation is an alternative to drug treatment or surgery for the treatment of intermittent claudication[8]. Exercise is a non-invasive, relatively inexpensive, and effective method for improving claudication pain symptoms[3]. Regular exercise improves walking performance in patients affected with peripheral obliterative arterial disease[12]. It is well known that exercise causes a strong local vasodilation in the exercising muscle. Furthermore, it would seem that muscular exercise is capable of widening collateral vessels[5]. Thus, it seems logical to use muscular exercise in the treatment of atherosclerotic disease of the legs associated with intermittent claudication[15]. Khobrey and Roy[11] even observed angiographic improvement in a series of patients with intermittent claudication and subjected to muscular training. There is suggestive evidence in scientific literature that increased physical activity has a beneficial effect on the course and severity of coronary heart disease[7]. It has been suggested that one possible mechanism for this protective influence has been that exercise may increase the collateral circulation to the myocardium, ischemia is considered to be a major stimulus for this increased vascularization. If this is indeed true, then it may also be possible to increase the collateral circulation to muscles that have inadequate blood flow due to arteriosclerosis obliterans[15]. So, the aim of this study was to evaluate the efficacy of physical training for six months on intermittent claudication through an objective measurements of pain-free and maximum walking times, ankle systolic pressure and calf blood flow before starting and after completion of the training.

## MATERIALS AND METHODS:

**Patients:** Ten patients, ranging in age from 46 to 62 years, (mean±SD 55.7±7.02 years), with stage II peripheral vascular disease, recruited to the study. All of them had been suffering from intermittent claudication for at least two years, which appeared after walking less than 300 meters and which had been stable in the previous three months. The diagnosis of peripheral vascular disease was confirmed by Doppler and angiographic findings.

All the patients had been heavy smokers but had stopped smoking at least one year previously. No patient had a case history of angina pectoris, myocardial infarcts, stroke or had undergone vascular surgery or percutaneous angioplasty in the preceding six months. Patients affected by impaired cardiac or lung functions, major liver, kidney, or metabolic diseases, infections, or cancer were excluded. A written informed consent was taken from each patient before starting the study.

## PROCEDURES

After resting for 20 minutes in supine position, the following tests were performed before the training program was begun, and after the end of six months training program.

**Doppler velocimetry:** the ankle systolic pressure was measured in the posterior tibial artery of the more severely diseased leg.

Standard treadmill test (12 degrees slope/5 minutes/2KmHr): the pain-free walking time (time in minutes from starting treadmill exercise to the appearance of pain) and the maximum walking time (time in minutes from the beginning to the end of treadmill exercise) were registered.

Strain gauge plethysmography: was used to evaluate the basal calf blood flow (rest flow:ml/100ml /min.) and the maximum calf blood flow after an ischemia was induced by applying a cuff to the lower third of the thigh and inflating it to a pressure of 240 mmHg. held for three minutes (peak flow:ml/100ml/min.).

**Training program:** the program consisted of three sessions per week, each session lasted for 30 minutes with five minutes warm-up period at first and five minutes cool-down at the end. The program was conducted for six months.

The intensity of the physical training was adjusted to the individual capacity of the patient, as each individual s training workload was 75% of his maximum walking time. The maximum walking time was reassessed every month, if it changed, the training workload then became 75% of the new maximum walking time.

**Statistical analysis:** all values were represented as mean±S.D. Two-tailed Student s t test for paired data and bivariate linear regression technique were used for the statistical analysis of the results with only P <0.05 being considered significant.

## RESULTS

After six months of physical training program, a significant increase in the value of the pain-free walking time was documented. It lengthened by 67% from 1.86±0.49 to 3.12±1.33 min. (P<0.05). The maximum walking time also improved by 294% increasing from 5.72±3.76 to 22.56±17.99 min. (P <0.05) (Table 1 and figure 1).

***Table (1): Pain Free and Maximum Walking Times Before and After Training Program.***

| Variable | Before training program | After training program | % differ. |
|---|---|---|---|
| | Mean±S.D. | Mean±S.D. | |
| Pain Free Walking Time (min.) | 1.86±0.49 | 3.12±1.33 | 67 % |
| Maximum Walking Time (min.) | 5.72±3.76 | 22.56± 17.99 | 294% |

P < 0.05

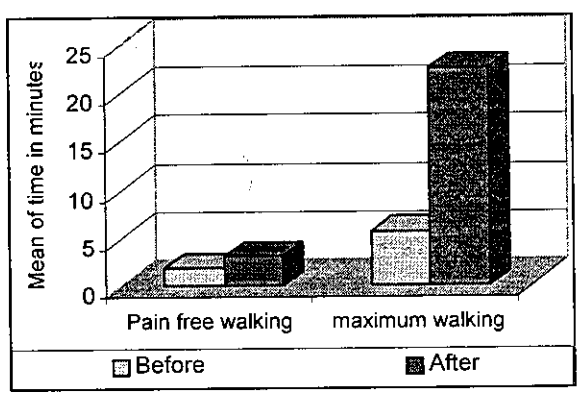


***Fig. (1): Mean of pain free and maximum walking time before and after training program.***

The same pattern of significant variation was observed in the results of the strain gauge plethysmography as the values of rest calf blood flow increased by 58% from 3.041.27 to 4.79±2.1ml/100 ml/min. (P< 0.05). The values of peak calf blood flow increased by 41% from 11.45±3.21 to 16.15±6.3ml/100ml/min. (P<0.05) (Table 2 and figure 2).

***Table (2): Resting and Peak Calf Blood Flow Before and After Training Program***

| Variable | Before training program | After training program | % differ. |
|---|---|---|---|
| | Mean±S.D. | Mean±S.D. | |
| Resting calf blood flow (ml/100ml/min.) | 3.04±1.27 | 4.79±2.1 | 58 % |
| Peak calf blood flow (ml/100ml/min.) | 11.45±3.21 | 16.15±6.3 | 41% |

$P < 0.05$

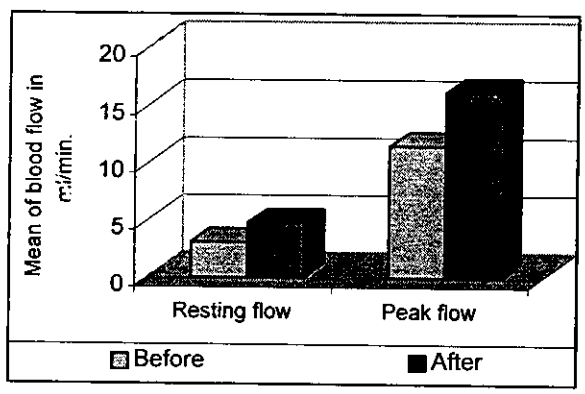


***Fig. (2): Mean of resting and peak calf blood flow before and after training program.***

A significant increase by 1.6% was observed in the values of the ankle systolic pressure which increased from 122.2±6.78 to 124.2±6.34mmHg. ($P<0.05$) (Table 3 and figure3). The linear regression analysis showed that there is a high positive correlation between the changes in pain-free and maximum walking time ($r = 0.62$), while there is a negative low correlation between changes in pain-free and rest calf blood flow ($r = -0.30$), peak calf blood flow ($r = -0.21$) and ankle systolic pressure ($r = -0.40$). The changes in maximum walking time had a low positive correlation with changes in rest calf blood flow ($r = 0.12$), peak calf blood flow ($r = 0.27$) and ankle systolic pressure ($r = 0.26$). There was a high positive correlation between rest and peak calf blood flow ($r=0.98$). Also, there was a high positive correlation between ankle systolic pressure and rest calf blood flow ($r = 0.84$) and peak calf blood flow ($r = 0.67$).

***Table (3): Ankle Systolic Pressure Before and After Training Program.***

| Variable | Before training program | After training program | % differ. |
|---|---|---|---|
| | Mean±S.D. | Mean±S.D. | |
| Ankle Systolic Pressure (mmHg.) | 122.2±6.78 | 124.2±6.34 | 1.6 % |

$P < 0.05$

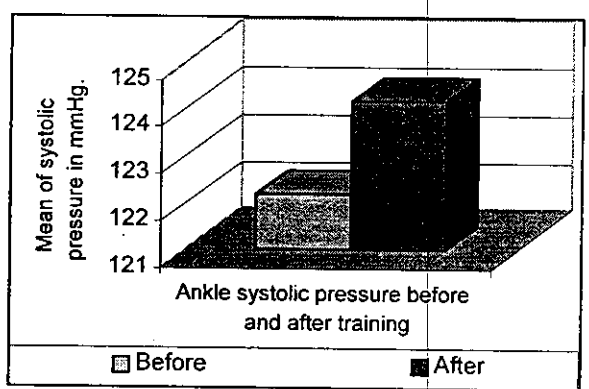


***Fig. (3): Mean of ankle systolic pressure before and after training program.***

## DISCUSSION

The study results have confirmed that physical training is the best conservative treatment for patients suffering from intermittent claudication.

Indeed six months physical training resulted in 67% and 294% increases in pain-free and maximum walking time respectively, thus notably enhancing the walking capacity in those patients. Also, there is 1.6% increase in ankle systolic pressure and 58%, 41% increases in both rest and peak calf blood flow respectively. The most likely explanation for the improvement in ankle systolic pressure

response to successive walks is that a progressive dilation of the collateral circulation occurred, this decreases the resistance to flow resulting in the delivery of an increased volume of blood to the exercising muscles[15]. General mechanisms leading to the improvement in walking performance in peripheral obliterative arterial diseased (POAD) patients would include an increase in oxygen supply or a reduction in metabolic demand of exercise[9]. Several mechanisms have been proposed to account for an increase in oxygen supply, including an increase in blood flow through the development of a collateral circulation, a redistribution of blood flow toward ischemic areas, and an increase in the capillaries of the blood vessels of the skeletal muscles[14]. Indeed, it has been shown that in (POAD) patients undergoing a treadmill training program a decrease in steady-state oxygen consumption ($VO_2$); is observed, together with an increase in peak $VO_2$[9]. Such metabolic changes could possibly reflect either an increase in local oxygen delivery or an improvement in muscle oxidative metabolism, as well as less energy expenditure to support a given intensity of exercise. Moreover, in POAD patients undergoing physical training, an improvement in whole blood viscosity (WBV) and filterability (WBF) has been observed[6]. WBV and WBF play a pivotal role in oxygen delivery to tissues. Any amelioration in the rheologic characteristics of blood may contribute to improve the perfusion of ischemic areas[13]. Yet, in POAD patients under a training program, the decreased oxygen consumption and the improved blood rheology may cooperate in delaying the onset of the mismatch between the limited oxygen supply and the metabolic cost of exercise[9]. More recently, the crucial role of the endogenous nucleoside adenosine has been highlighted. Adenosine is a product of purine metabolism that is released by local tissues in ischemic conditions, together with the nucleotide adenosine triphosphate (ATP). ATP induces endothelium dependent vasodilation and helps preservation of cell integrity. Interestingly, adenosine is also able to improve the rheologic characteristics of blood and to reduce skeletal muscle oxygen consumption, thereby reproducing some events associated with treadmill training[2].

Conclusion:Thus, an overall evaluation of the results obtained with the different outcome measurements allows the conclusion that physical training is a fundamental treatment for patients with intermittent claudication.

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## الملخص العربي

### فوائد ممارسة برنامج تدريبي لمدة ستة أشهر في حالات نقص التغذية الدموية للعضلات

أجريت هذه الدراسة على عشرة من المرضى الذين يعانون من تقلصات عضلات الأطراف السفلية نتيجة لإصابتهم بأمراض الشرايين الطرفية ، و قد تراوحت أعمارهم بين ستة وأربعين واثنين وستين عاما .
و كان الهدف من هذه الدراسة هو معرفة تأثير ستة أشهر من التدريبات على تلك التقلصات العضلية المتقطعة . وقد تم قياس كل من زمن السير بدون ألم، أقصى زمن للسير، معدل سريان الدم في عضلة الساق (في حالة الراحة، وأعلى معدل للسريان) و كذلك ضغط الدم الانقباضي بالكاحل قبل بداية و بعد انتهاء التدريبات.وقد أظهرت النتائج وجود زيادة ملحوظة في معدلات كل القياسات بعد انتهاء التدريبات مما يدل على تحسن حالة هؤلاء المرضى . ويمكن أن تعزى هذه الزيادة إلى تكيف سريان الدم في الأطراف ، إعادة توزيع سريان الدم ، تحسن كمية الأوكسجين المتجهة للعضلات نتيجة لنقص لزوجة الدم أو زيادة كثافة الشعيرات الدموية .
كذلك يمكن أن نستنتج أن التدريبات تعتبر عاملاً علاجياً مهماً للمرضى الذين يعانون من تقلصات عضلات الأطراف السفلية .