Scand J Rehab Med 19: 47–50, 1987

PREDICTION OF THE EFFECT OF TRAINING ON THE WALKING TOLERANCE IN PATIENTS WITH INTERMITTENT CLAUDICATION

Tommy Jonason and Ivar Ringqvist

From the Department of Clinical Physiology, Västerås Central Hospital, S-721 89 Västerås, Sweden

ABSTRACT. **The possibility of predicting the effect of training on the walking tolerance in intermittent claudication has been studied. After three months of supervised training in 54 patients, the maximal walking distance (MWD) increased by 67 % and the painfree walking distance (PFD) by 91 %. The analysis of the relation between tested background variables and the effect of training showed covariation only in 14 % of the increase in MWD and in 19 % of the increase in PFD. The possibility of predicting the effect of training on the walking tolerance in the individual patient with intermittent claudication is limited.**

Key words: arterial occlusive disease, intermittent claudication, physical training, atherosclerosis

Physical training is often prescribed for many patients with intermittent claudication. The beneficial effect of supervised in-hospital training (4, 5, 6, 11, 12, 13) and also of training at home (7) on the walking tolerance has been reported in several studies. The results of training has been reported to be similar in patients with aorto-iliac and with femoro-popliteal arterial occlusive disease (5, 6). In many patients with claudication and coronary heart disease, however, training has a poor result (6).

The present study was undertaken to determine whether there is any relationship between the increase in walking tolerance achieved with training and various background variables in patients with intermittent claudication but without angina pectoris. Such relationship could facilitate the selection of patients who will benefit from training.

PATIENTS AND METHODS

Patients

The study initially comprised 63 patients under 80 years of age with intermittent claudication and a walking distance of less than 1 000 m at the treadmill test. Exclusion criteria were a history of rest pain, previous vascular surgery, signs of left ventricular failure, a history of angina pectoris, or ST deressions on ECG at the treadmill test.

The ankle/arm blood pressure index (ABI) was measured twice within one week in 141 other patients with intermittent claudication. The 95 % confidence limit for the difference in ABI between these two measurements was found to be ±0.15, i.e. a change in ABI of 0.16 or more is considered to represent a significant change in the peripheral circulation. At the test after completed training ABI had decreased with more than 0.15 in nine patients, indicating a deterioration in the peripheral circulation. These nine patients were therefore excluded from the study.

The remaining 54 patients, 13 women and 41 men, had a mean age of 65±7 (SD) years. Thirty-nine were smokers. Twenty-three patients had had their claudication for one year or less, 31 for more than one year.

Examination

The patients underwent a combination of segmental blood pressure (BP) measurements and evaluation of the velocity and direction of the flow in the common femoral and popliteal arteries with the Doppler shift technique (6). The location of the arterial disease was determined by a combination of segmental BP measurement and assessment of the pulses with the Doppler shift technique (8). The accuracy in localization of the occlusive arterial disease was validated in 50 other patients with intermittent claudication, using angiography as the reference method. The diagnostic accuracy of our non-invasive method for detecting significant stenoses (≥50 %) was 87 % for aorto-iliac, 85 % for femoro-popliteal and 88 % for combined aorto-iliac and femoro-popliteal arterial disease.

Thirty-two patients displayed signs of femoro-popliteal disease, five of aorto-iliac and 17 of combined aorto-iliac and femoro-popliteal disease.

In 39 patients the calf blood flow was measured by plethysmography at rest and after five minutes of ischemia, with rapid extensions and flexions of the feet during the last minute. The post-ischemic maximal blood flow was measured.

The maximal walking distance (MWD) was measured on a treadmill. The patients started with a load of 30 W, which was then increased by 30 W every sixth minute. The speed of the treadmill was 1 m/s. ECG was recorded continuously during the test and the systolic BP was measured at each load. The test was stopped when the pain was no longer bearable, or at a high degree of exhaustion, or after the 120 W load (=1 440 m). The leg pain was rated according to a 0–8 Borg scale (3), and the degree of exhaustion according to a 6–20 Borg scale (2).

The tests were performed before and at the end of the three months of supervised training, and six months after the end of this training period. The test six months after

Table I. *Results from the walking tolerance tests on a treadmill before and after three months of supervised training and six months after the training*

Mean ± SD. N=54. The six-month test was performed by 51 patients, and the ankle blood pressure was measured in 44 of them. MWD=maximal walking distance, PFD=painfree walking distance

	Before training	After three months of training	Six months after completed training (n=51)
MWD (m)	427±216	712±318	689±490
	***	***	*
PFD (m)	106±66	202±130	189±125
	***	***	NS
Leg pain at MWD (degree 0–8)	6.7±1.4	6.8±1.2	6.0±1.6
	NS	**	*
Exhaustion at MWD (degree 6–20)	15.2±2.0	15.2±1.8	15.0±2.2
	NS	NS	NS
Time taken for disappearance of leg pain after work (min)	7.5±6.1	5.8±4.7	5.3±3.4
	**	**	NS
Ankle blood pressure (mmHg)	93±19	89±22 (n=54)	
	*		
		93±19	93±16 (n=44)
		NS	

* $p<0.05$, ** $p<0.01$, *** $p<0.001$.

completion of training was performed by 51 patients (one could not perform the test because of back pain, and two refused).

Training

The patients trained in groups under the supervision of a physiotherapist for 45 min twice a week for three months. Before the training started the patients were given information about the disease and about available means of treatment. They were also instructed to perform physical exercise at home. The importance of stopping smoking was emphasized. The patients attendance at the training sessions averaged 88% (range 32–100%). The training consisted of simple movements such as walking, jumping, dancing and ropeskipping until almost maximal pain occurred. The most effective training is achieved in the standing position. At each session most of the patients also exercised on bicycles.

Statistical methods

Student's two-tailed t-test was used for comparison of means. A stepwise multiple regression analysis was performed and only variables with $p<0.15$ for the regression coefficients were included in the regression model. $p<0.05$ was considered as statistically significant.

RESULTS

Walking distance (Table I)

MWD and the painfree walking distance (PFD) increased significantly with training. There was a slight but significant decrease in the ankle BP.

MWD increased from 451 to 766 m in the 37 patients with single stenoses ($p<0.001$), and from 375 to 595 m in the 17 patients with multiple stenoses ($p<0.001$). The increase in MWD did not differ significantly between these two groups of patients.

At the test six months after the completion of the supervised training MWD was slightly but significantly decreased compared with that at the end of the training period. PFD did not differ significantly between these two tests, and there was no further decrease in the ankle BP. A lower degree of leg pain was attained at this test. As at the test after three months of training, the time taken for disappearance of the leg pain after work was shorter than at the pre-training test.

Analysis of the increase in maximal and painfree walking distances (Table II)

The increases in MWD and PFD after three months of training were analyzed by multiple stepwise regression analysis. The following independent variables were tested: age, sex, smoking, compliance to the training sessions, duration of the claudication, single vs. multiple arterial stenoses, post-ischemic blood flow in the calf, ankle BP and ABI at rest and four minutes after the pre-training test and the pre-training MWD and PFD.

Table II. *Multiple stepwise regression analysis of the increase in maximal and in pain-free walking distance after three months of training.*

The coefficient of determination (R^2) obtained when each variable was entered is presented. B=the regression coefficient and p=the level of significance for the coefficient. ABI=ankle/arm blood pressure index. N=54

Variable	R^2	B	p
Increase in maximal walking distance			
ABI at rest	0.10	446.9	$p<0.05$
Age	0.14	−6.5	$p<0.12$
Increase in pain-free walking distance			
ABI at rest	0.07	224.1	$p<0.05$
Duration of claudication	0.14	−62.4	$p<0.05$
Sex	0.19	65.6	$p<0.08$

The independent variables were classified: Duration of claudication: 0=<one year, 1=≥one year; sex: 0=man, 1=woman.

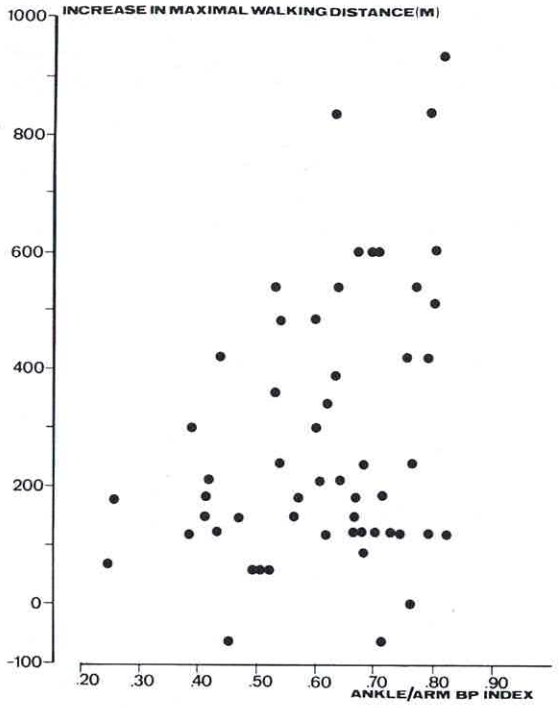

Fig. 1. The increase in the maximal walking distance on a treadmill as a function of the ankle/arm blood pressure index at rest. The correlation coefficient was 0.32 ($p<0.05$).

Only 14% of the increase in MWD could be explained by a combination of ABI at rest and age. No other variable was included in this regression model. MWD increased with a higher ABI and decreased with a higher age, but only the regression coefficient for ABI was statistically significant.

A regression model comprising ABI at rest, the duration of claudication and sex explained 19% of the increase in PFD. No other variable was included. PFD increased with a higher ABI, a shorter duration of the disease, and increased more in women than in men. Only the regression coefficients for ABI and duration were statistically significant.

Smoking habits

Five of the 39 smokers stopped smoking after the initial examination. Nineteen patients decreased their smoking from 19±11 g/day to 10±6 g/day after the initial examination. There were no significant correlation between the increase in MWD or PFD and smoking habits, or changes in smoking habits, during the training period.

DISCUSSION

The increase in the maximal walking distance was of the same magnitude as has been noted in several other studies (4, 5, 6, 11, 12, 13). In two of the studies (5, 6) no difference was found between the effect of training in patients with aorto-iliac and femoro-popliteal disease. In the present study there was no significant difference in the result between patients with single and multiple (combined aorto-iliac and femoro-popliteal) stenoses. The increase in maximal and painfree walking distances were almost maintained six months after the end of the supervised training. As at the test after training, the time taken for disappearance of the leg pain after work, was shorter than at the pre-training test. However, a lower degree of leg pain was attained at the test. One explanation to this could be that many patients were limited by exhaustion and not by claudication at the test six months after training. This indicates that the patients continued training at home with a persisting effect on the peripheral arterial circulation. This training, however, had less effect on the general conditioning.

As the purpose with this study was to determine whether there is any relationship between common

clinical variables and the result of training, patients with signs of deterioration of the peripheral circulation were excluded from the analysis. In one study (6) only 14 of 24 patients with angina pectoris and intermittent claudication increased their walking distance. We therefore did not include patients with angina pectoris in our study.

Only 14% of the increase in the maximal walking distance was related to the tested variables, mainly the ankle/arm blood pressure index. The scatter diagram of this index plotted against the increase in the maximal walking distance (Fig. 1) showed a considerable overlap. Thus, this index has no clinical value for selecting patients who will benefit from training. For the pain-free walking distance the result was of the same magnitude, 19% of the increase being explainable by the ankle/arm blood pressure index, the duration of the disease and sex. This finding is also of little practical value for selecting patients for training.

Smoking is a risk factor for the development and progression of the disease (8, 9, 10). The walking tolerance is decreased after exposure to carbon monoxide (1). There were however no correlation between smoking habits during the training, or changes in smoking habits, and the increase in walking tolerance.

In conclusion, the possibility of predicting a beneficial effect of physical training in the individual patient with intermittent claudication without angina pectoris, with common clinical characteristics and peripheral circulatory conditions, is limited. We do not seem to be able to select patients in whom a good or poor result of training might be expected. Future studies including metabolic variables might perhaps improve the possibility of selecting patients for training. A training period of three months can therefore be recommended for all patients, without contraindications against training, before surgery is further considered.

ACKNOWLEDGEMENT

This study was supported with grants from the County Council of Västmanland.

REFERENCES

1. Aronow, W. S., Stemmer, E. A. & Isbell, M. W.: Effect of carbon monoxide exposure on intermittent claudication. Circulation 49: 415, 1974.
2. Borg, G.: Perceived exertion as an indicator of somatic stress. Scand J Rehab Med 2–3: 92, 1970.
3. Borg, G. & Linder, J.: A comparison between different category scales for evaluation of subjective symptoms. Report from the Institute of Applied Psychology, University of Stockholm, No. 78, 1979.
4. Dahllöf, A. G., Björntorp, P., Holm, J. & Scherstén, T.: Metabolic activity of skeletal muscle in patients with peripheral arterial insufficiency. Eur J Clin Invest 4: 9, 1974.
5. Ekroth, R., Dahllöf, A. G., Gundervall, B., Holm, J. & Scherstén, T.: Physical training of patients with inermittent claudication: Indications, methods and results. Surgery 84: 640, 1978.
6. Jonason, T., Jonzon, B., Ringqvist, I. & Öman-Rydberg, A.: Effect of physical training on different categories of patients with intermittent claudication. Acta Med Scand 206: 253, 1979.
7. Jonason, T., Ringqvist, I. & Öman-Rydberg, A.: Home training of patients with intermittent claudication. Scand J Rehab Med 13: 137, 1981.
8. Jonason, T., Ringqvist, I.: Factors of prognostic importance for subsequent rest pain in patients with intermittent claudication. Acta Med Scand 218: 27, 1985.
9. Jonason, T. & Ringqvist, I.: Changes in peripheral blood pressures after five years of follow-up in patients with intermittent claudication. Acta Med Scand 220: 127, 1986.
10. Kannel, W. B. & Shurtleff, D.: The Framingham study. Cigarettes and the development of intermittent claudication. Geriatrics 28: 61, 1973.
11. Larsen, A. & Lassen, N.: Effect of daily muscular exercise in patients with claudicatio intermittens. Lancet 2: 1093, 1966.
12. Sörlie, D. & Myhre, K.: Effects of physical training in intermittent claudication. Scand J Clin Lab Invest 38: 217, 1978.
13. Zetterquist, S.: The effect of active training on the nutritive blood flow in exercising ischemic legs. Scand J Clin Lab Invest 25: 101, 1970.

Address for offprints:

Tommy Jonason
Department of Clinical Physiology
Västerås Central Hospital
S-721 89 Västerås
Sweden