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IMPORTANT PREDICTORS OF THE OUTCOME OF PHYSICAL TRAINING IN PATIENTS WITH INTERMITTENT CLAUDICATION

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ABSTRACT. Hemodynamic and endocrine variables have been unsuccessful to predict improvement in walking distance in patients with intermittent claudication following structured training programs. In the present study we evaluated the predictive value of a number of hemodynamic and endocrine parameters. In addition we included information on cognitive factors such as stress and the belief in the structured training and motivation to participate. Twenty-five elderly subjects were studied. Significant improvement in overall walking distance was achieved. The most important explanatory variables of relative improvement in walking distance were belief in training, initial walking distance and number of smoke years. The results support the belief that cognitive factors are of major importance in predicting functional effects of structured training programs for patients with intermittent claudication.

Key words: intermittent claudication, exercise therapy, ankle blood pressure, hormones, cognitive factors, prediction.

The beneficial effect of physical training is well documented in patients with peripheral vascular disease and intermittent claudication (IC) (4, 8, 13, 14). However, so far the possibility to predict the outcome of physical training in patients with IC have been limited (1, 9). Nevertheless, it is today of most importance to concentrate limited resources on the appropriate individuals and to identify factors that could facilitate in the selection of patients who will benefit the most from structured training.

Metabolic and neuroendocrine factors are most likely of importance for the arteriosclerotic process (5, 6). These factors are affected by physical training (4, 14) and it has been proposed that they can be used for predicting the effect of training, even though this remains to be evaluated (9). Furthermore, it has been found that personality factors are related to the outcome of training programs for patients with IC (10, 11) suggesting that mental parameters also can be of value for predicting the effect of physical training. However, overall, prior studies have failed to identify physiologic factors or lifestyle factors that predicts the greater part of the variance in improvement in walking distance following structured training of patients with intermittent claudication.

The purpose of the present study was to identify significant predictors of improvement in walking capacity following a prospective controlled training program for older patients suffering from IC. We included hemodynamic, physiologic, metabolic and neuroendocrine parameters as well as smoking habits and a number of mental and cognitive factors.

MATERIAL AND METHODS

The study group comprised 25 patients, 15 men and 10 women with a mean age of 68 years (range 55–76). Exclusion criteria were diabetes mellitus and evidence of ischemic heart disease. The peripheral occlusive disease was ascertained by non-invasive methods. During treadmill test all patients were limited by typical IC symptoms. Twenty-two of the patients smoked at the start of the program, but all patients stopped smoking during the training period.

All patients were studied with oscillometry, peripheral blood pressure measurement and digital plethysmography at the Department of Clinical Physiology. Blood samples were taken and analysed for glucose, fructosamine, insulin, growth hormone, cortisol and prolactin. Hormone levels were determined in duplicates by radioimmunoassay with commercially available kits. Intraassay and interassay coefficients were below 10% and 20%, respectively.

A six-month training program of two training sessions of 30 min each twice a week at the hospital combined with daily training at home was lead by an experienced physiotherapist. At the first visit to the physiotherapist all patients answered a standardised questionnaire. The questionnaire concerned to what degree the disease caused obstacles in daily life, the degree of worry over the disease, overall emotional stress

Table I. *Predictors of relative improvement in walking distance in meter, adjusting for initial walking distance*

Independent variables	Parameter estimate	*p*-value
Intercept	−102.6	0.22
Initial walking distance in meter	−0.14	0.0006
Belief in effect of training	0.96	0.08
Smoke years	4.36	0.02

Adjusted *r*-square for model is 0.51 and overall probability 0.003.

level, emotional state at the time of the testing, the motivation to participate in the structured training and the personal belief that training is beneficial to one's condition. The questionnaires were designed as classical visual analogue scales allowing for a continuous variable response.

Treadmill tests were performed before and after the training period. The speed used was 1 $m \times sec^{-1}$. The patients started for six min on a flat level and continued for six min with an external load of 30 Watt, determined by inclination related to body weight. The load was then increased by 30 Watt every sixth minute. To control for differences in initial walking ability we transformed improvement in m to a percentage improvement variable (=walking distance after training−walking distance before training/walking distance before training).

Statistics. Student's *t*-test and regression analyses with the least square technique using Statistical Analysis System (SAS). Only significant predictors at the $p=0.05$ or less level, two-sided, were included, and residuals were checked to ensure random distribution. Adjusted *r*-squares are given.

Data are expressed as mean ± SEM.

RESULTS

The walking distance increased from 575±69 m to 924±92 m after six months of training ($p<0.001$).

The percentage increase in walking distance, adjusting for initial walking distance, was studied by regression analyses. We found no relation between walking improvement and the hemodynamic parameters, including ankle blood pressures, recorded during the initial evaluation prior to initiating the training sessions. Neither could the basal pretraining level of any of the tested hormones and metabolic factors predict the outcome of the training program.

However, walking distance at the first treadmill test in m, the belief one has that training will have an effect and the number of smoke years were found to be good predictors of percentage increase in walking distance. The combination of these three factors could explain 51 % of the improvement after training (Table I). The less initial walking distance, the more improvement. For the other two parameters there were positive associations.

Age and sex had no significant predictive effect in any of the models tried.

DISCUSSION

Previous reports have documented that IC is a risk factor for mortality (2, 7). In most studies clinical and hemodynamic variables have been found to be of limited value for predicting the outcome of the disease (3, 12). In line with earlier observations (1, 9) we found that these variables were unable to predict the outcome of a physical training program in patients with IC.

Our results indicate that cognitive factors are most critical for the outcome of the training program. The patient's belief that he/she will improve was found to be an important predictor of the result. By using a combination of cognitive factors, initial walking distance and smoking habits we could explain as much as 51 % of the variance of the percentage increase in walking distance. Our results fit well into the general observation that fulfilments of patients' expectations are closely linked with compliance with treatment (11). It is thus likely that patients with a true belief in the structured program actually were more dedicated to the advise given by the physiotherapist and adhered to the program to a larger degree than those that did not believe the structured program was the appropriate treatment for their condition. These results further underline the important role for the physiotherapist in managing these patients.

Extensive smoking habits did not impede improvement. On the contrary, the longer a person had smoked in years, the more likely he/she was to improve. To be noted is also that the training program included cessation of smoking. The most disabled patients, regarding initial walking distance, were found to improve the most. This suggests that intensive training is of most value in these patients and in times of limited resources they should have priority.

Even though the group studied mainly contained rather old persons they were found to benefit substantially from the training program, although age per se was not an important predictor of the outcome.

We have in an earlier study demonstrated that exercise training has beneficial effects on neuroendocrine

and metabolic parameters (14). However, in the present study these factors were found to add little to predict the percentage improvement of walking distance.

In conclusion, we were able to predict the outcome of physical training in patients with IC by using a combination of background variables and mental factors. A patient with short initial walking distance and extensive smoking habits will most likely benefit from training, providing he stops smoking and has a belief that training will have a positive effect. Hemodynamic and metabolic parameters were of limited predicting value.

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