Supervised and home-based exercise training for patients with intermittent claudication

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J Wang, S Zhou, R Bronks, J Graham, S Myers. Supervised and home-based exercise training for patients with intermittent claudication. *Int J Angiol* 2008;17(3):137-140.

Home-based exercise training, applied as the primary treatment in patients with intermittent claudication, has produced inconsistent effects on walking capacity in previous published studies. The aim of the present study was to evaluate whether a home-based exercise training program could maintain improved walking capacity and other functional variables achieved through a supervised exercise training program. The present design was a 48-week self-controlled study. The first 12-week period was a control stage in which no prescribed exercise program was provided, the second 12-week period was a supervised treadmill-walking training program and the following 24-week period was a home-based exercise program. Twenty-two subjects with intermittent claudication were recruited

initially; 15 of them (14 men and one woman) completed the whole program. Walking capacity, peak oxygen uptake, walking economy and ankle-brachial index were measured at baseline and at 12, 24 and 48 weeks. There was no significant change in the measured variables after the control stage. The 12-week supervised treadmill-walking training program significantly increased pain-free walking time, maximal walking time and peak oxygen uptake. Walking economy was also significantly improved. These improvements were successfully maintained after 24 weeks of home-based training. The results indicated that 12 weeks of supervised treadmill-walking training followed by a home-based training program is an effective model of exercise rehabilitation for patients with intermittent claudication.

Key Words: *Functional capacity; Home-based exercise training; Peripheral arterial disease*

METHODS

Study design

The present 48-week investigation consisted of three stages. The first 12-week period was a control stage with no prescribed exercise program, the second 12-week period was a supervised treadmill-walking training program and the following 24-week period was a home-based exercise program. Walking capacity, peak oxygen uptake (VO_2), walking economy (WE) and ankle-brachial systolic blood pressure index (ABI) were measured at baseline and at 12, 24 and 48 weeks.

Subjects

Volunteer subjects were recruited from the local population of the Northern Rivers region of New South Wales, Australia. The selection criteria included: age between 50 and 80 years, resting ABI below 0.90 that decreased to below 0.80 after a treadmill test, and a stable history of IC for at least six months. The following conditions excluded participation: resting ischemic pain, ulceration or gangrene in the legs; inability to walk on the treadmill at a speed of 3.2 km/h; and exercise capacity limited by symptoms of angina, congestive heart failure, chronic obstructive pulmonary disease or arthritis. The present study was approved by the Human Research Ethics Committee of Southern Cross University, Australia. Informed consent was obtained from each subject.

Measurements

With the subject in a supine position, systolic blood pressure was measured at the brachium and ankle using a bidirectional

Peripheral arterial disease is an atherosclerotic disease that mostly affects older populations (1,2). A study in Australia (3) reported that the prevalence of the disease was 10.6% in men 65 to 69 years of age and 23.3% in men 75 to 79 years of age. This prevalence is expected to rise as our society ages. Intermittent claudication (IC) is the most common symptom of peripheral arterial disease (4). It is a severe muscular pain that presents while walking, usually in the calf muscle. This symptom seriously limits walking capacity (5) and reduces the quality of life (6) of patients.

Exercise training was demonstrated to be an effective treatment that improves the walking capacity of patients with IC (5,7). Supervised programs usually increase patients' walking capacity following 12 to 24 weeks of training (8-14), while the evidence on the effectiveness of home-based programs, when applied as the primary treatment, is equivocal (15-17). However, supervised programs are costly, and it is not always feasible for elderly patients to travel to rehabilitation centres. Therefore, it is important to develop an effective way for patients to apply home-based exercise programs. The present study examined whether a home-based exercise program, applied as the secondary treatment, could maintain the beneficial effects obtained during a previous supervised training program for patients with IC. The aims were to examine the effects of a 12-week supervised exercise training program on walking capacity and other functional variables, and to evaluate whether a 24-week home-based exercise program could maintain the benefits from the supervised exercise training.

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TABLE 1
Walking capacity, peak oxygen uptake (VO₂), walking economy and ankle-brachial index throughout the study period

	Baseline	12 weeks	24 weeks	48 weeks
Pain-free walking time, s	120±63	143±73	395±277*	377±258†
Maximal walking time, s	299±115	331±138	722±188*	675±175†
Peak VO ₂ , mL/kg/min	13.29±2.20	12.95±2.20	14.78±2.79§	14.40±1.74
Walking economy, mL/kg/min	11.97±2.15	11.50±1.96	9.60±0.97§	9.97±1.49†
Ankle-brachial index	0.61±0.22	0.64±0.17	0.67±0.19	0.65±0.18

All data are presented as mean ± SD. †P<0.01; ‡P<0.001, 48-week test versus baseline test; §P<0.01; *P<0.001, 24-week test versus 12-week test

Doppler MD5 unit (DE Hokanson Inc, USA). The ABI was calculated as the systolic pressure at the posterior tibial or dorsalis pedis arteries divided by the systolic pressure at the brachial artery. In a graded treadmill test (18), walking time before the occurrence of claudication was measured as pain-free walking time (PFWT). The time to maximal pain, when the subject could walk no longer, was recorded as maximal walking time (MWT). A five-point scale was used to identify the pain level (19), in which 1 = no pain, 2 = onset of claudication, 3 = mild pain, 4 = moderate pain and 5 = claudication. Peak VO₂, defined as the average of the two highest connected 15 s VO₂ values achieved during the test (20), was measured by a MedGraphics CPX/D System (Medical Graphics Corporation, USA). WE, the oxygen uptake at a given speed of walking, was measured in a constant-load treadmill test, in which the walking speed and incline were fixed at 3.2 km/h and 0%, respectively (14). Subjects were then asked to report the pain level they experienced while walking. The test was terminated at 20 min, even if the subject could walk longer. For comparability, the WE values in all tests were calculated over the exact time period as the baseline test.

Supervised exercise training program

An individual treadmill-walking training program was prescribed according to the outcomes of the 12-week test. Subjects trained in the laboratory for 1 h per session, at three sessions per week for 12 weeks. Each subject started walking at 3.2 km/h with an individualized incline. This combination elicited moderate claudication (level 4 on the five-point scale) after approximately 5 min of walking. Subjects stopped and rested in a sitting position when they felt moderate claudication. They resumed when the pain resolved. Each time the subject could walk for a 7 min interval without moderate claudication, the treadmill incline was increased by 0.5%, until it reached 5%. The walking intensity was further augmented by increasing treadmill speed by 0.5 km/h each time. The progressive increase of exercise intensity aimed to provide continuous overloading to improve walking capacity while training. All training sessions were supervised by the researcher; an electrocardiogram (modified lead II configuration) was monitored when exercise intensity was increased.

Home-based exercise program

At the completion of the supervised exercise training, an individualized written exercise program was provided to each subject. Subjects were asked to do three or four 1 h walking sessions per week. Each walking session was to include warm-up, interval walking and cool-down stages, similar to the supervised training session. However, subjects walked in the street near their homes. The walking intensity was also controlled at moderate claudication. The researcher contacted the subjects by telephone every two weeks and a face-to-face interview was conducted after 12 weeks of the home-based exercise program. All communications were aimed at encouraging compliance and providing consultation if the subjects had any questions regarding the training program.

Statistical analysis

ANOVA with repeated measures was performed to detect the effect of the treatments at each stage of the study on PFWT, MWT, peak VO₂, WE and ABI. Post hoc analysis with Bonferroni adjustment was applied to reveal significant differences if a significant overall effect was identified. All variables were presented as mean ± SD. An alpha level of 0.05 was chosen to determine significant differences between the mean values. All statistical analyses were performed using the SPSS statistical software package (SPSS Inc, USA).

RESULTS

Twenty-two subjects were recruited initially. Five subjects dropped out of the study during the control stage – two of them terminated the participation due to myocardial infarction, one had a stroke and the other two moved away from the region. Seventeen subjects completed the 12-week supervised treadmill-walking training program. Two subjects had shoulder surgery during the 24-week home-based training program and missed the final test. Therefore, experimental data of 15 subjects who completed the whole 48-week program were analyzed and reported in the present paper. There were 14 men and one woman. Their mean age (± SD) was 71±8.3 years and mean body weight was 79.6±14.0 kg. At baseline, resting ABI was 0.61±0.22 and postexercise ABI was 0.41±0.23.

All measured variables showed no significant changes during the control stage. The 12-week supervised treadmill-walking training program significantly increased subjects' PFWT, MWT and peak VO₂. The WE was also significantly improved, which indicated a lower oxygen uptake at the given walking speed. These improvements were well maintained after 24 weeks of home-based training. There was no significant change in the ABI throughout the program (Table 1).

At baseline, only three subjects could walk for longer than 10 min in the constant-load treadmill test. After the supervised treadmill-walking training, 13 of the 15 subjects could walk for longer than 10 min. This improvement was maintained until the conclusion of the present study.

DISCUSSION

The main finding of the present study was that the 12-week supervised treadmill-walking training program significantly increased the walking capacity of this group of subjects. More importantly, the 24-week home-based exercise program successfully maintained this improvement. The walking capacity, peak VO₂ and WE were maintained at better levels than the baseline values.

There has been a report in the literature (17) that home-based exercise programs maintained the effects of training on maximal walking distance achieved through 12 weeks of supervised exercise training in patients with IC. Another study (21) noted that the improved walking capacity after exercise training would deteriorate within six months if the subjects did not continue to exercise regularly. The present findings support regular exercise to maintain beneficial training effects in patients, even with minimal supervision.

Home-based exercise programs have been used as a primary intervention in patients with IC; however, the outcomes have been inconsistent. One study (16) compared the effects of a hospital-based exercise program with a home-based exercise program and reported that the home-based training did not improve walking capacity or peak oxygen consumption. The authors indicated that individual motivation and self-administered exercise intensity may be the two major factors contributing to the noneffectiveness of the home-based exercise program. In contrast with higher levels of supervision that included weekly educational lectures and telephone reviews, other studies reported that home-based exercise programs significantly increased PFWT (17), as well as MWT or mean walking distance (15,17).

Unlike the uncertain outcomes of home-based exercise programs, 12 to 24 weeks of supervised exercise training has shown definite benefits in walking capacity (9,11,22). However, supervised exercise programs need a higher level of commitment from the patients, and sophisticated equipment such as treadmills and electrocardiogram monitors. From the long-term social and economic viewpoint, a less structured, home-based exercise program would be more practical for the patients.

The present study demonstrated an effective use of supervised and home-based exercise for the subjects – a short-term supervised exercise training program combined with a long-term home-based exercise program. In this way, the basic skills of

walking intensity control, warm-up and cool-down activities were introduced and practised during the supervised exercise training. The successful maintenance of improved functional capacity was attributable to the educational role of the supervised exercise training. In addition, monitoring the training progression with regular telephone calls from the researcher may have also played an important role in ensuring adherence to the exercise program and the quality of training. As a result, the subjects can enjoy higher functional capacity for a longer time through a self-administered home-based exercise program. The results of the constant-load treadmill test also showed a satisfactory outcome. At 48 weeks, most subjects in the present study could walk longer than 10 min, which corresponded to 500 m. This capacity enabled the subjects to walk from the car park to targets (shop, post office, medical centre, etc) in their daily life. With the increased mobility and independence, the quality of life would be enhanced significantly as a result of this exercise program.

The results concerning resting and postexercise ABI from the present study agreed with previously reported research (9,11,19). Although there was a significant increase in walking capacity, the ABI did not show any significant change following exercise training. As indicated in a review (23), the ABI has been thought of as a reflection of the changes in systolic blood pressure in the arteries; it may not correlate with the blood supply to active muscles during walking.

CONCLUSION

The present study demonstrated that when subjects were monitored regularly and educated on how to exercise, their improved walking capacity, which was achieved through a supervised exercise training program, was well maintained through a home-based exercise program, with minimum cost and supervision. Therefore, we report that supervised training for 12 weeks followed by home-based exercise is an effective model of exercise therapy for patients with IC.

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